The Edmund SKY GUIDE

by Terence Dickinson and Sam Brown

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ABOUT THE AUTHORS

The Edmund Sky Guide is the innovative idea of the late Sam Brown who over the years wrote many books on Astronomy, Optics and Telescopes for the Edmund Scientific Co. and others. His inimitable style and hand-drawn illustrations have educated, informed and delighted thousands. We were sorrowed by his death in 1976 and although the manuscript was incomplete, we knew that Sam would want it finished.

Fortunately, Terence Dickinson, a former editor of Astronomy magazine and long-time admirer of Sam's works, was able to bring his wealth of knowledge and experience to the completion of Sky Guide.

Mr. Dickinson is a former editor of the Ontario Science Centre, Toronto, Canada; former assistant director of the Strasenburgh Planetarium, Rochester, N. Y.; and former scientific assistant for the McLaughlin Planetarium of the Royal Ontario Museum. The creator of 18 planetarium programs, he is also the author of more than 300 science articles that have appeared in major magazines, newspapers and journals in the United States and Canada.

The Edmund Sky Guide, the product of these two accomplished men, is the first detailed guidebook to the night sky that takes you easily, and pleasurably, from the Big Dipper to the Andromeda Galaxy and beyond.

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CONTENTS

INTRODUCTION 1

SKY MOTION 3

STARS 4
Bright Stars, Faint Stars

MEASURING SKY DISTANCES 6
Identifying Constellations

SKY GUIDE CHARTS 8
The Deneb Connection
The Pegasus Connection
The Orion Connection
The Hydra Void
Follow The Arc
Star Names

THE VISIBLE SKY 16
The Planets
Binoculars As Astronomical Instruments
Telescopes And Their Uses
Double And Multiple Stars

DEEP SKY WONDERS 22
Open Clusters
Nebulae
Planetary Nebulae
Globular Clusters
Galaxies

FINDING TELESCOPIC SKY OBJECTS 26

SKY MAPS 31

PRONOUNCING GUIDE 36

Introduction

It was no more than a few million years—a mere swing of the cosmic pendulum—that a manlike creature first raised his eyes to the sky and wondered about those flickering lights in the night. Before that the stars shone for more than four billion years on a planet whose creatures were too obsessed with surviving from one day to the next to question night's mysteries.

In the minds of our prehistoric forebears, stars were only curious glimmers in the darkness. But night after night as the same stars passed in review, a belief emerged that the stars must be fixed like pinholes in a velvet blanket enshrouding our planet while the sun is gone.

Thus began the march of knowledge that has brought us to current celestial concepts of black holes, quasars and the expanding universe. Today's contemplation of the night sky is hampered by the fact that most of us find it necessary to live in or near highly illuminated cities. Artificial light has obliterated the grandeur that sparked human curiosity so long ago.

Yet the same technological advances that have robbed city dwellers of the spectacle of the Milky Way arching from horizon to horizon also allows us, in only a few hours, to flee to country retreats where the sky can be seen as it should be. This book—a guide to the night sky—has purposely been designed to be useful in both circumstances, from areas forested with street lights to the darkest rural observing site.

Unless you live in the downtown core of a city with a million or more population you can always see at least a few stars on a clear evening. This book will help you guide yourself around the night sky even if you have never identified a single star before. And if you haven't you are not alone.

Surveys conducted in planetariums reveal that more than half the visitors admitted they could not identify any stars, planets or constellations in the night sky except for (perhaps) the Big Dipper and the North Star. But that doesn't mean people aren't interested in astronomy; quite the reverse is true.

Curiosity about the universe is at an all-time high. Magazines on the subject sell in greater numbers than ever before. More telescopes have been sold in the last decade than in the previous century. Back in 1960 few universities offered astronomy courses, but today even small colleges have introductory courses in the subject.

This surge in interest in the universe is only partly due to spacecraft explorations beyond this planet. Recent theoretical evidence suggesting that mankind is not the only intelligent species in the universe, and that life itself is an integral part of the cosmic fabric, has made astronomy much more than the esoteric study it was popularly pictured as back in the 1950's.

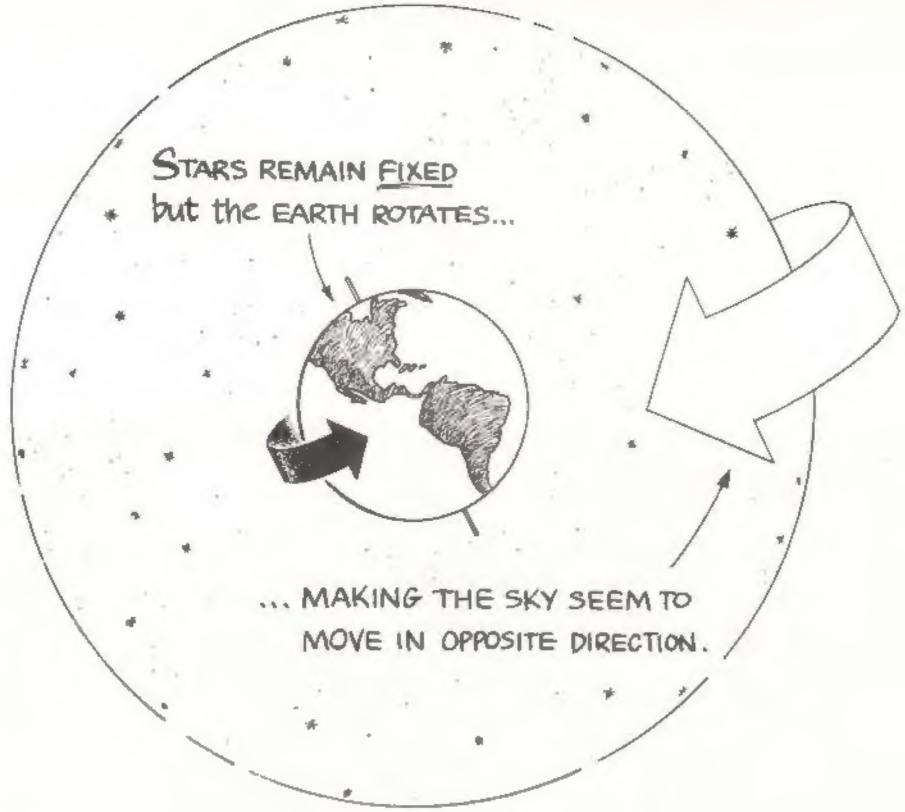
In those days amateur astronomers scanning the night with binoculars or homebuilt telescopes were considered by friends and relatives to have a bizarre interest that could barely be dignified with the description "hobby." Today, that's all changed. Whether you have a telescope or not, exploring the universe from your backyard or a rural retreat is true involvement with the cosmos that harbors our own origins.

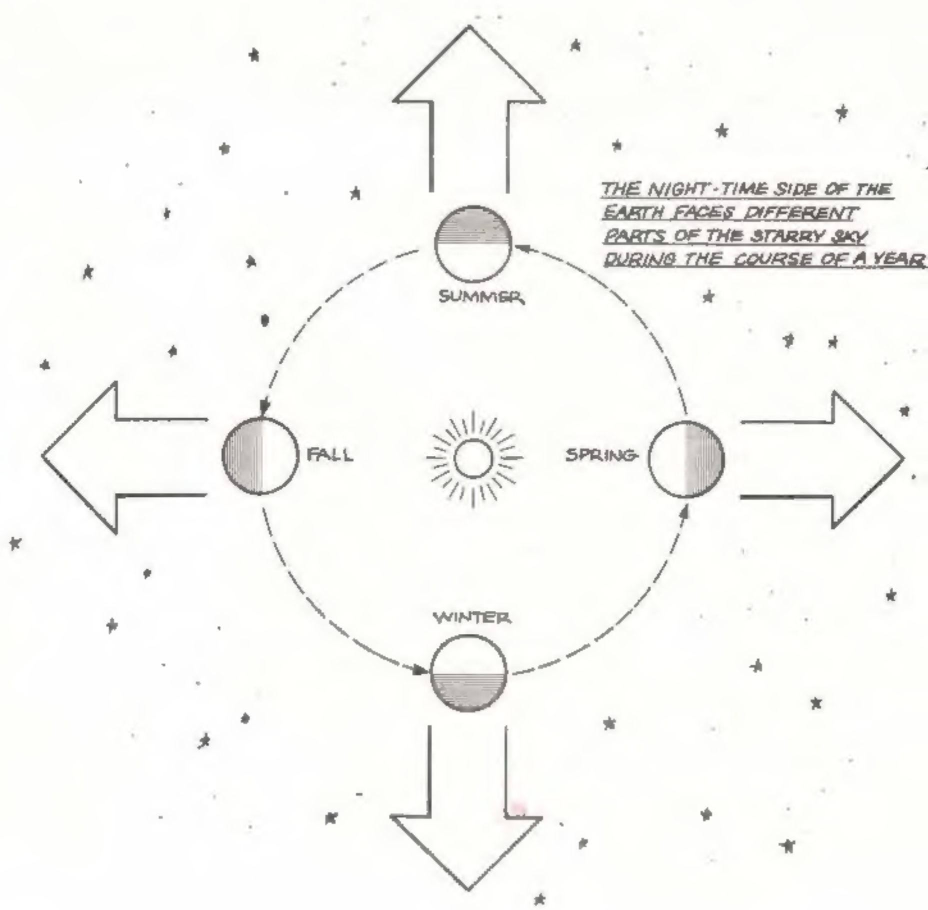
This book is roughly divided into two parts: first, a detailed step-by-step guide to the night sky starting with the assumption that you can locate the Big Dipper but not much else. (If you are beyond this stage you may want to skim through the first few pages.)

The second part of the book consists of a catalog and descriptions of the finest objects in the sky for small telescopes. Here the emphasis is on how to find them and what they look like.

Even if you don't have a telescope, you may have binoculars. Many of the objects can be glimpsed—and a few are very well seen—with binoculars. We will specify what types of instruments are best for various objects.

Enter then, the universe of suns of all sizes and colors, galaxies with pinwheeling arms, and clusters swarming with stars still wreathed in the swirling clouds of gas and dust that incubated their nuclear fires. All can be found once you know where to look. It's enjoyable and rewarding and all you need to get started are your eyes and a cloudless night sky.





Sky Motion

The night sky is basically a static vista of stars. An occasional meteor slices the sky, the moon with rigid precision passes through its phases from night to night, and planets disguising themselves as bright stars appear to slowly traverse the sky while they ply majestic orbits around the sun.

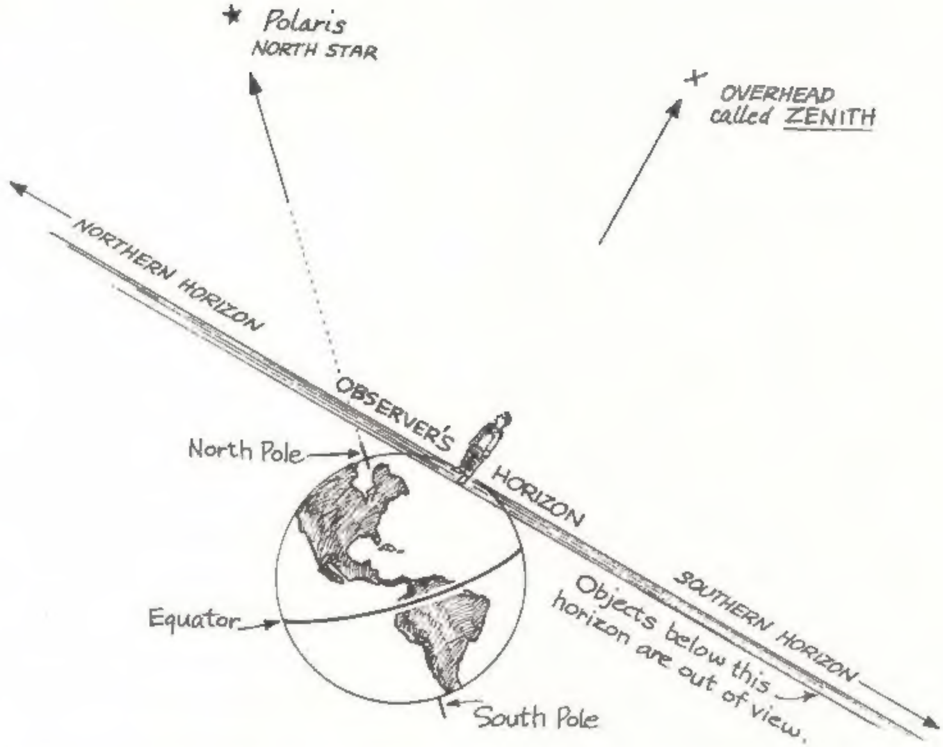
But the moon, planets and stars are merely actors on an enormous celestial stage whose backdrop and scenery are the thousands of stars that have been observed since mankind first wondered about the universe. The components of this stellar scenery are the same no matter when you look.

Of course only half of the sky can be seen at any one time—the Earth is in the way and therefore hides the other half. As our planet rotates on its axis different stars are constantly being brought into view while others drift below the horizon. This motion results in the illusion that the sky is doing the moving and the Earth is fixed.

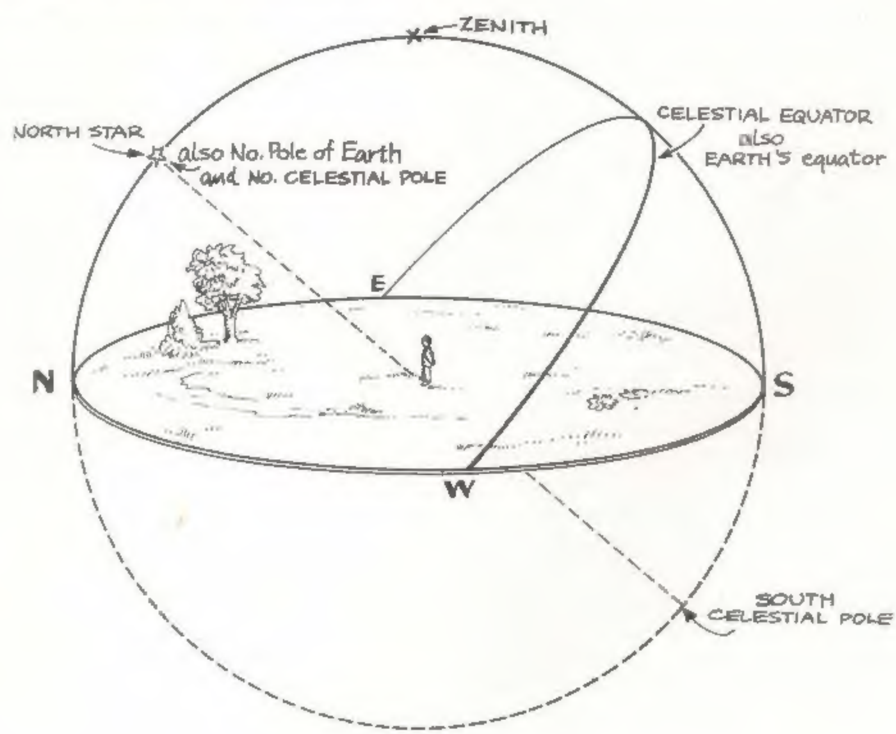
The illusion is so convincing that it wasn't until the second century B.C. that the concept of a rotating Earth was suggested, and it took until the 16th century before the idea began filtering down to the general population.

If you face south, stars appear to move slowly from left to right due to the Earth's rotation. It takes at least a quarter of an hour to notice a change and you won't notice it even in that length of time unless you use a reference point like the top of a post or the branch of a tree, observed from a constant location.

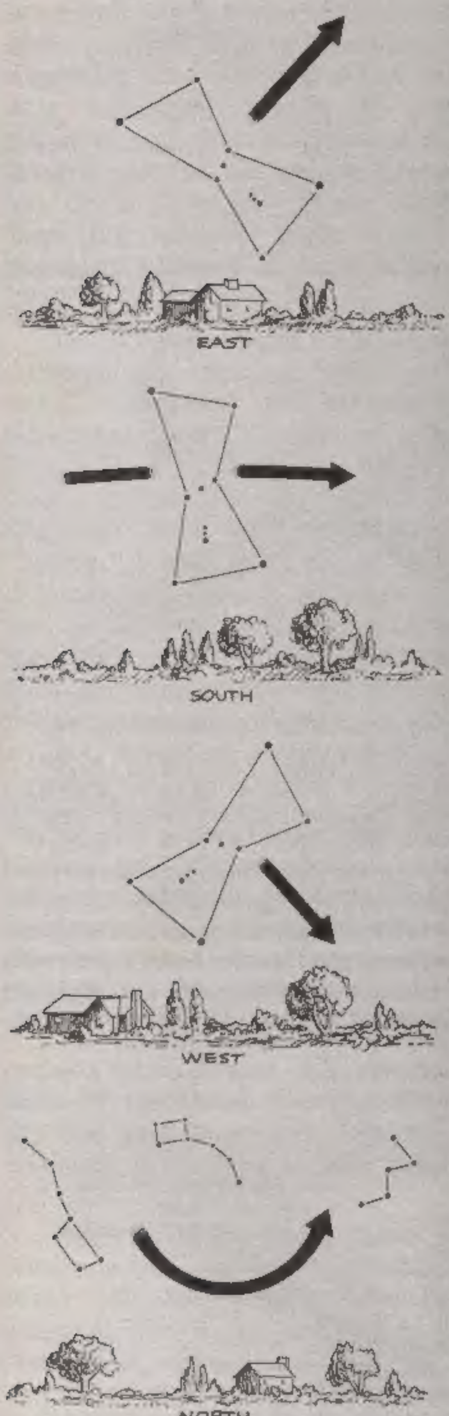
Facing west, the stars appear to dip down toward the horizon on an angle from upper left to lower right. The motion here is more rapid and can be noted in just a few minutes if the object you are watching seems close to something on the horizon. The same effect



It doesn't matter where you are on our spinning globe, your horizon and the earth beneath your feet obscure half of the sky at any particular time (illustration above). Although the overhead point changes from moment to moment due to our planet's rotation and revolution around the sun, certain celestial markers always remain fixed. The north celestial pole — the point directly above the north pole of the Earth — is conveniently marked in the sky by Polaris, the north star. Although Polaris is not precisely at the north celestial pole it is close enough to mark the spot for most practical purposes. The celestial equator is not so easily found nor as useful to the casual observer. It is directly above Earth's equator and, like the Earth's celestial pole, is fixed in the sky. Because it is not marked by any single star the celestial equator can be identified by a number of stars near it that you will discover as you become familiar with the maps in this book.



Apparent Sky Motions



Earth's rotation makes all sky objects seem to move together in a majestic celestial procession. Stars that rise in the east will slowly move across the sky as a group and eventually set in the west. Stars in the north seem to pivot around the north celestial pole near Polaris, a motion that reflects Earth's pivoting on its axis. Since half the sky is visible at any one time, there are always plenty of bright stars or major star groups to identify.

occurs in reverse in the east where sky objects rise from lower left to upper right.

Facing north the stars don't rise and set at all but seem to wheel around a pivotal point very close to Polaris, the North Star.

During the night the Earth's rotation carries the stars, moon and planets in unison according to the general patterns just outlined. Everything moves together except for Polaris, which seems to stand still. Polaris is almost precisely above the north pole of the Earth and, like the planet's pole, acts as a pivotal point.

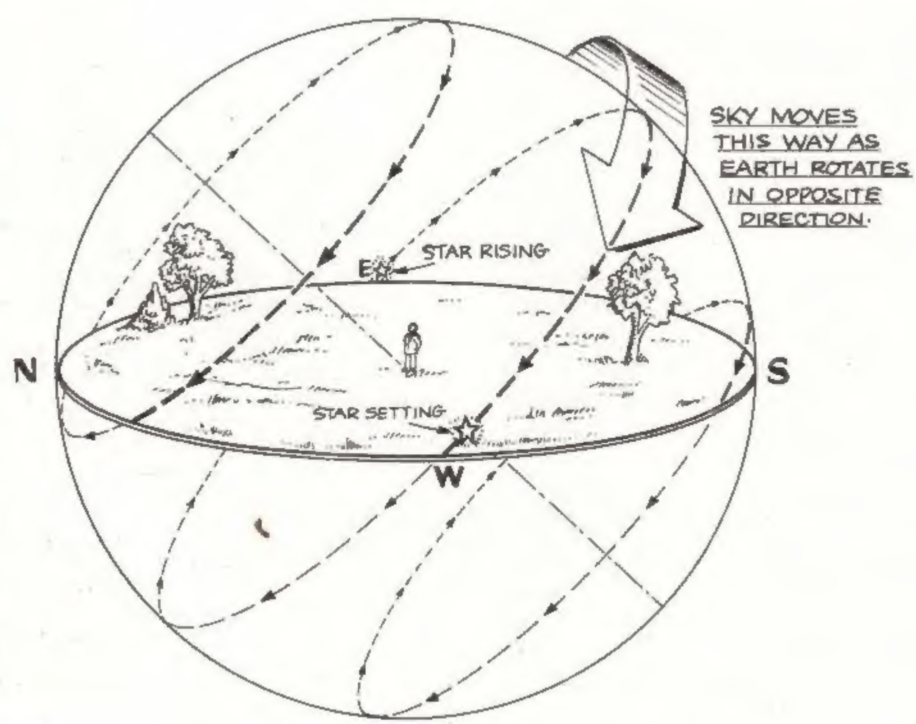
Everything in the sky moves as if it were attached to a colossal celestial sphere far beyond the Earth. As observers on the spinning Earth, we see the celestial sphere move past in the same way that a child on a merry-go-round sees the spectators and the amusement park pass in review on every rotation of the merry-go-around's turntable. To carry this analogy further, if the child were to look straight up (and we removed the canopy over the top of the merry-go-around) the sky above would seem to spin around a fixed point, the axis of the device.

Sky motions are a never-ending procession ordained by the laws of gravity. In most instances the procession is so ponderous that it becomes imperceptible over short time periods. But from season to season whole star groups move out of view and are replaced by others in an annual cycle.

Stars

Stars are the citizens of the universe. Like people, they reside in groups ranging from a colossal metropolis like the Milky Way Galaxy with a population of over 200 billion stars, down to small sub-groups of tens or hundreds of stars in clusters. The sun, a member of the Milky Way Galaxy, is accompanied in its local zone of space by its family of planets, asteroids, comets and other celestial debris.

Compared to the distances between the sun and its planets, the distances to the "nearby" stars are enormous. Pluto, the sun's outermost planet, orbits our star at an average distance forty times



greater than Earth's, but the nearest star is 5000 times farther away than Pluto. Many of the stars visible in the night sky are hundreds of times more remote.

Stars, like people, come in all sizes. However, the range among stars is far greater than the differences among humans. Betelgeuse, the largest star known, is about 800 times the diameter of the sun. The smallest visible stars are white dwarfs, many of which are smaller than the Earth. Neutron stars, detected only by indirect means, are a mere 10 miles in diameter.

However, the giants are the star performers. As the compilation to the right reveals under the column marked Luminosity not a single one of the fifty brightest stars visible from northern latitudes is as feeble in its light output as the sun. Yet astronomers tell us that the sun is brighter than the average star. The majority of the galaxy's stars are small and dim, part of a classification called red dwarfs. Despite their large numbers even nearby red dwarfs are barely perceptible with the unaided eye and most can only be seen by telescope.

The brightness of the night sky is due entirely to the giants of the Milky Way Galaxy, those stars that are radiating their energy in greater amounts than the sun. Some stars like Rigel and Deneb are among the brightest in the entire galaxy and, even though they are vast distances away, rank among the brightest visible stars.

Star distances listed in the table are given in light-years (one light-year is 5,878,450,000,000 miles). The nearest star, Alpha Centauri, is 4.3 light-years away. (Alpha Centauri is not visible from the continental United States.)

Although most stars appear as diamond-like, twinkling white points, they do, in fact, come in a variety of colors ranging from reddish-orange to bluish. These different hues, due to each star's surface temperature, can be noticed

THE 50 BRIGHTEST STARS

Name	Mag.	Dist.	Lum.	Spec.	R.A. h.m.	Dec. °
Sirius	−1.6	8.7	23	AO	6 43	−16.7
Canopus	−0.7	98	1500	FO	6 23	−52.7
Arcturus	−0.1	36	110	K2	14 14	+19.4
Vega	0.0	27	52	AO	18 36	+38.8
Capella	0.1	45	140	GO	5 14	+46.0
Rigel	0.2	900	55000	B8	5 13	− 8.3
Procyon	0.4	11.3	8	F5	7 37	+ 5.4
Betelgeuse	0.4*	520	15000	MO	5 54	+ 7.4
Altair	0.8	16.6	10	A5	19 49	+ 8.8
Aldebaran	0.9	68	150	K5	4 34	+16.5
Antares	1.0	520	10000	M1	16 28	−26.3
Spica	1.0	220	1700	B2	13 24	−11.0
Fomalhaut	1.2	23	13	A3	22 56	−29.7
Pollux	1.2	35	33	KO	7 43	+28.1
Deneb	1.3	1600	55000	A2	20 40	+45.2
Regulus	1.4	84	155	B8	10 07	+12.1
Castor	1.6	45	35	AO	7 33	+32.0
Adhara	1.6	680	9000	B1	6 57	−28.9
Bellatrix	1.6	470	3800	B2	5 24	+ 6.4
Shaula	1.6	310	1700	B1	17 32	−37.1
Elnath	1.7	300	1500	B7	5 24	+28.6
Alnilam	1.7	1600	4200	BO	5 35	− 1.2
Mirfak	1.8	570	4700	F5	3 22	+49.8
Dubhe	1.8	105	150	KO	11 02	+61.9
Alioth	1.8	68	70	AO	12 53	+56.1
Gamma Velorum	1.8	520	3500	O	8 09	−47.3
Kaus Australis	1.8	124	220	B9	18 22	−34.4
Alnitak	1.8	1600	35000	O9	5 39	− 2.0
Al Nair	1.8	64	60	B7	22 06	−47.1
Alkaid	1.9	210	600	B3	13 46	+49.5
Alhena	1.9	105	140	AO	6 36	+16.4
Wezen	1.9	2100	55000	F8	7 07	−26.4
Lambda Scorpii	1.9	650	3500	FO	17 35	−43.0
Menkalinan	1.9	88	100	A2	5 57	+45.0
Mirzam	2.0	750	7000	B1	6 21	−17.9
Delta Velorum	2.0	76	65	AO	8 44	−54.6
Polaris	2.0	680	5500	F8	2 03	+89.1
Alphard	2.0	94	110	K4	9 26	− 8.5
Hamal	2.0	76	70	K2	2 05	+23.3
Diphda	2.0	57	38	K1	0 42	−18.2
Theta Centauri	2.0	55	35	KO	14 05	−36.2
Mirach	2.0	76	11	MO	1 08	+35.5
Nunki	2.1	300	1000	B2	18 53	−26.3
Rasalhaque	2.1	58	38	A5	17 34	+12.6
Alpheratz	2.1	90	90	B9	0 07	+28.9
Algol	2.1*	105	130	B8	3 06	+40.8
Kochab	2.1	105	130	K4	14 51	+74.3
Almach	2.1	260	750	K3	2 02	+42.2
Saiph	2.1	2100	50000	BO	5 54	+ 7.4
Schedar	2.1	150	225	KO	0 39	+56.4

USING THIS TABLE: The table lists the 50 brightest stars visible from 35° north latitude. Almost all of them are visible from significantly north of that latitude. Every star listed is identified on at least one chart in this book. Stars are listed in order of brightness. The **Name** given is the star's common (usually Arabic) name although each star also has a Bayer designation — a Greek letter followed by the constellation name in genetive form. Lambda Scorpii, for example, is a star that does not have a common name other than the Bayer designation. Column headed **Mag.** lists the star's magnitude or brightness. A difference of 1/10 of a magnitude is difficult to distinguish without special equipment. However, a few tenths of a magnitude difference between stars is quite obvious. First magnitude stars are those between 0.5 and 1.4; second magnitude is between 1.5 and 2.4, and so on. A star 1.0 mags brighter than another is 2.5 times brighter. Sirius is 28 times brighter than Schedar. An asterisk indicates a star that varies in brightness. **Dist.** refers to the star's distance from us in light-years. One light-year is about 5.9 trillion miles. **Lum.** designates each star's brighteness compared to the sun. For example, Sirius is 23 times more luminous than the sun if the two were placed side by side. **Spec.** is the spectrum of the star according to a system that is somewhat difficult to get used to. The letter refers to the spectral class indicating the star's temperature (see text) while the number is the subclass. For example, within the range of the B classification the subclasses are B0, B1, B2 through to B9 with B0 the hottest and B9 the coolest in the B classification. (A way that countless astronomers have learned the order of spectral classes from hot to cool is by memorizing "*Oh Be A Fine Girl Kiss Me!*") **R.A.** and **Dec.** are the star's Right Ascension and Declination, the celestial version of longitude and latitude. Using the maps on pages 31 to 35 each star can be found by using the co-ordinate scales. Some of the concepts mentioned here are explained more fully elsewhere in this book.

with the unaided eye once your attention is drawn to them.

In the table, the color of the star is indicated by its classification under the column headed Spectrum. In the letter-number combination for each spectral designation, the number can be ignored for color interpretation purposes. The letters are astronomical jargon and can be decoded with this table:

Spectral Type	Temperature Celsius	Color
O	above 30,000	blue
B	10,000 to 30,000	bluish-white
A	8,000 to 10,000	white
F	6,000 to 8,000	yellowish-white
G	4,600 to 6,000	yellow
K	3,700 to 4,600	yellow-orange
M	2,200 to 3,700	reddish-orange

Of course, to find the stars in the list you have to know where in the sky they are located, and that is what much of this book is about. To gaze at Deneb, for example, and recall that its light was produced some 1600 years earlier on a star so bright and hot it makes our sun insignificant by comparision, is one of the many cerebral pleasures of sky-gazing.

Bright Stars, Faint Stars

Some stars are dazzling bright while others are barely perceptible. The extent of the brightness difference between the brightest star and the faintest visible on the darkest nights is a factor of almost exactly 1000. For convenience, this large range has been divided into equal segments called magnitudes.

A star of first magnitude is 2½ times brighter than one of second magnitude which is 2½ times brighter than a third magnitude star and so on. The faintest stars are sixth magnitude and the brightest are generally of the first magnitude. However, six stars are too bright to fall within the first magnitude category and are rated zero magnitude, or 2½ times brighter than the average first magnitude star. Two others, Sirius and Canopus, are brighter still and have been placed at minus one magnitude. (See bright star list.)

Modern photometric equipment has enabled astronomers to measure accurately differences of 1/100 magnitude. To the unaided eye a difference of a half a magnitude is easy to notice. Experienced observers can almost always distinguish one star only 2/10ths of a magnitude brighter than another.

Most stars have a steady light output like the sun, varying less than one percent from one year to the next. Only a handful of stars visible to the unaided eye are noticeably variable in brightness.

Betelgeuse in the constellation Orion varies over a period of years a few tenths of a magnitude from its average of +0.4. No other stars above magnitude 2.0 vary enough to be noticed without special equipment.

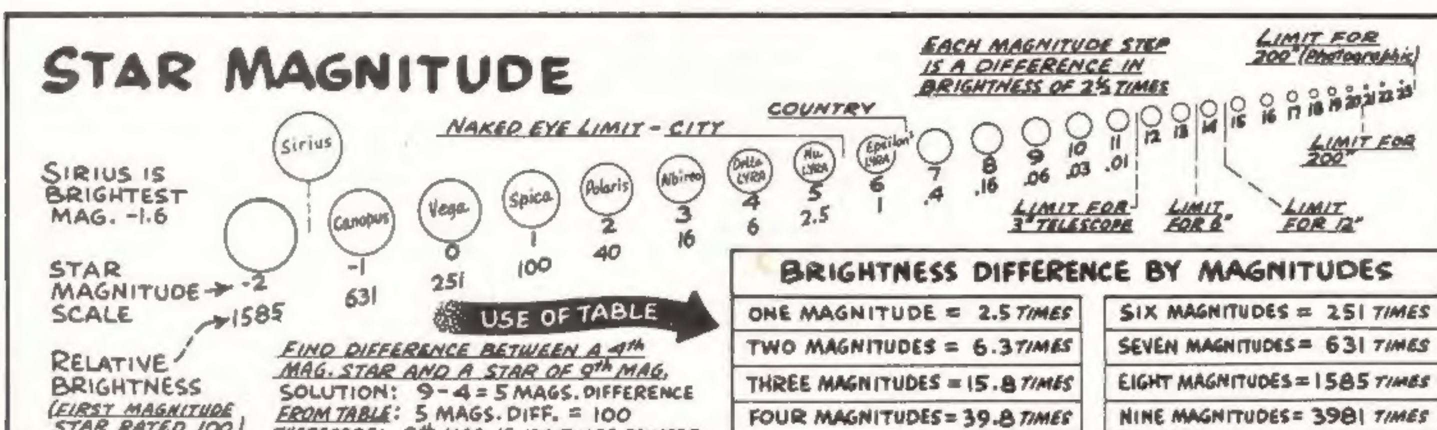
For practical purposes, the stars are of constant brightnesses and remain fixed in the same positions relative to one another for an entire human lifetime. Once you know them, it's simply a matter of reintroducing yourself to the sky every clear night.

Measuring Sky Distances

A key element in your knowledge of the night sky is the positional relationships of the stars and constellations. What at first seems to be a celestial jigsaw will eventually emerge as a coherent picture in your mind. To ease the familiarization period, it is useful to know the system of sky measurement which is based on the circle and its 360 degrees.

The sky appears to be a hemisphere, or half a sphere. Thus, a line from one horizon to the other passing through the zenith (overhead point) would be 180 degrees in length. From the horizon to the zenith is a quarter of a circle or 90 degrees. Halfway from the horizon to the zenith is 45 degrees, and so on.

A convenient sky measuring device, marked off in degrees, is the human hand. The various digital configurations illustrated yield a variety of angular measures in degrees—and they work for anyone's hand with remarkable



accuracy. If you need a distance larger than your hand can supply, a twig broken into a one foot length and held at arm's length appears about 30 degrees long.

The maps on the following pages contain many references to angular distances in degrees between one object, or star group, and another. Memorizing the approximate degree values for various finger and hand configurations at arm's length will give you a portable "sky ruler."

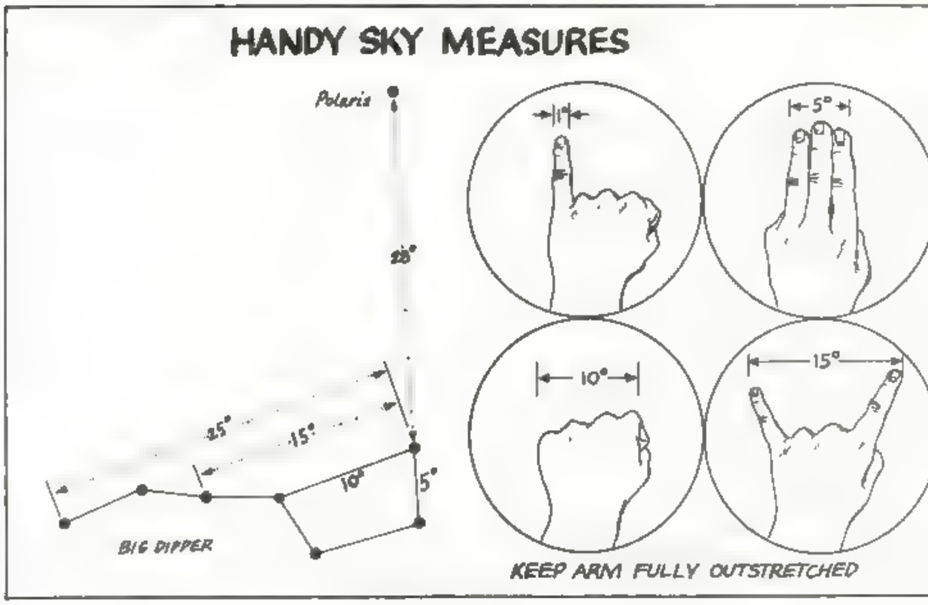
On a smaller scale, the sun and the moon are only one half degree in apparent diameter although they seem larger because of their brightness. Yet either can be easily covered by the tip of your little finger held at arm's length. Angular measures in the sky of less than one degree are stated in minutes of arc and measurements less than one minute are given in seconds of arc. The abbreviations used for degrees, minutes and seconds are ° , ' , ".

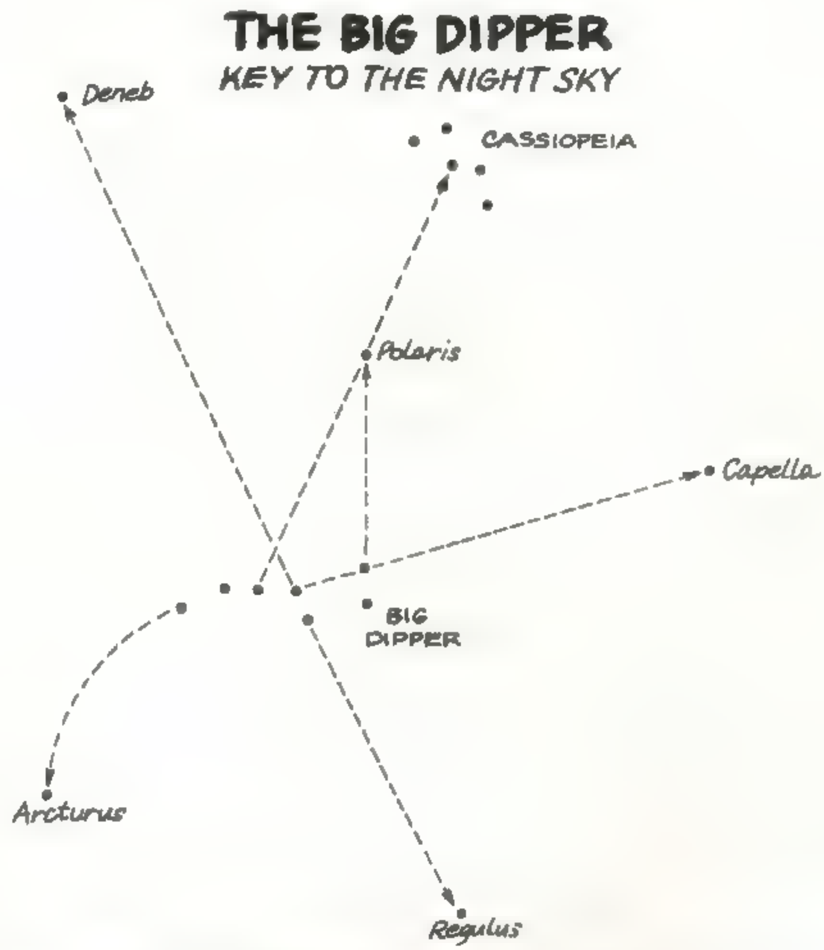
(These divisions should not be confused with hours, minutes and seconds of right ascension which we will encounter later.)

We will discuss this subject in detail later, but for now angular measure in degrees is all you need to know to find the major guideposts of the sky.

Identifying Constellations

Like the land areas of the Earth, the night sky has been divided by mankind into political sectors, partitioned from one another by artificial boundaries. Of course, no one claims ownership of any piece of the sky, but we have inherited a sky lore that grouped various stars under designations like Orion, Gemini and Taurus for reasons that were somewhat political in their time. Characters from Greek and Roman mythology found their way into the sky along with intriguing legends. The whole sky is intertwined with animals, heroes and villains that provide a romantic flavor of a long-gone era. (The saga of who and what got the





By some cosmic coincidence the Big Dipper stars are arranged so that they conveniently point at most of the major bright stars in the sky. This diagram can be used at any time of any night of the year because the stars do not change their positions relative to one another. What does change is the direction that you face into space due to Earth's rotation and revolution. This means that although the Dipper itself will always be visible (if you live north of 38° north latitude) not all of the stars that are indicated in this diagram will be above the horizon at any one time. Once you have identified some of the major guide stars you can then turn to the appropriate connecting map on the following pages to continue your sky exploring.

right to be in the sky is a book in itself.)

Modern astronomers have retained the ancient constellations for reasons of tradition and convenience. Today the entire sky is divided into 88 constellations that, by international convention, have fixed boundaries and designations. In only a few cases do the constellations actually look like what they were named for. With a little imagination the stars of Orion the hunter, for example, do outline something like a man holding a shield and a club. Leo, the lion, does bear moderate resemblance to the reclining king of beasts. However, finding a charioteer among the stars of Auriga or a beautiful queen in the area designated Cassiopeia is practically impossible.

For this reason we have chosen not to use the shapes of the traditional constellations at the outset in guiding you into the night sky. Instead, we'll assume nothing more than an ability to locate the Big Dipper. Once you've found the major guidepost stars, it becomes easy to fill in the blanks using the charts toward the back of the book. This process of learning the detail of the sky will, of course, involve learning the constellations. The final step is using the constellations to find the sky's interesting telescopic sights.

Sky Guide Charts

The Deneb Connection

The "summer triangle" is a modern stellar configuration consisting of Deneb, Vega and Altair — the brightest stars in three constellations that happen to be nearly overhead during summer. To be sure you have located the correct three stars, check their configuration against the key in the upper right hand section of the main map. From these three bright stars the outlines of the Northern Cross (part of Cygnus) and the stars of the small constellation Lyra can be readily identified.

Finding the remaining stars and constellations in the summer sky has always been difficult for the beginning astronomer. Our map solves that problem by using Deneb as a pivotal point—hence the "Deneb Connection." By extending sighting lines from Deneb through the triangle and beyond, four major stars or star groups can be added to the summer sky.

Easiest of these to identify is Antares, a brilliant, reddish, first magnitude star about the brightness of Altair. Antares is always fairly close to the southern horizon and its red color should mean instant identification using the sighting line indicated from Deneb down the Northern Cross a distance of 95°.

Antares means "the rival of Mars." Whenever the red planet is in this part of the sky the two look very similar. Since Antares is not far from the planets' pathway it is possible that the place where Antares should be has more than one "star." If this is so, Antares will be the reddish twinkling one while a planet will have a steadier light.

To the east of Antares and slightly closer to the southern horizon is the "teapot" configuration of Sagittarius—a true constellation in the historical sense. According to legend Sagittarius is an archer but you'll probably find it much easier to identify the teapot shape, with the spout on the right and the handle on the left, than to distinguish any hunter with his bow and arrow.

In a large dim section of the sky to the southwest of the summer triangle (below and to the right as you face south), second magnitude Rasalhague stands out as a relatively bright star. Rasalhague belongs to the constellation Ophiuchus, a sprinkling of third and fourth magnitude stars filling much of the region between Antares and Hercules. Both Ophiuchus (the serpent bearer) and Hercules are ancient constellations that bear little resemblance to their names.

A quadrilateral of third magnitude stars shown in our Deneb Connection map is the most prominent part of Hercules. Even so, it is the most difficult of the identifications to make because of the relative faintness of the stars. We would have ignored it except for the fact that the most impressive globular cluster visible from northern latitudes is contained within the quadrilateral. It's a real showpiece in a telescope.

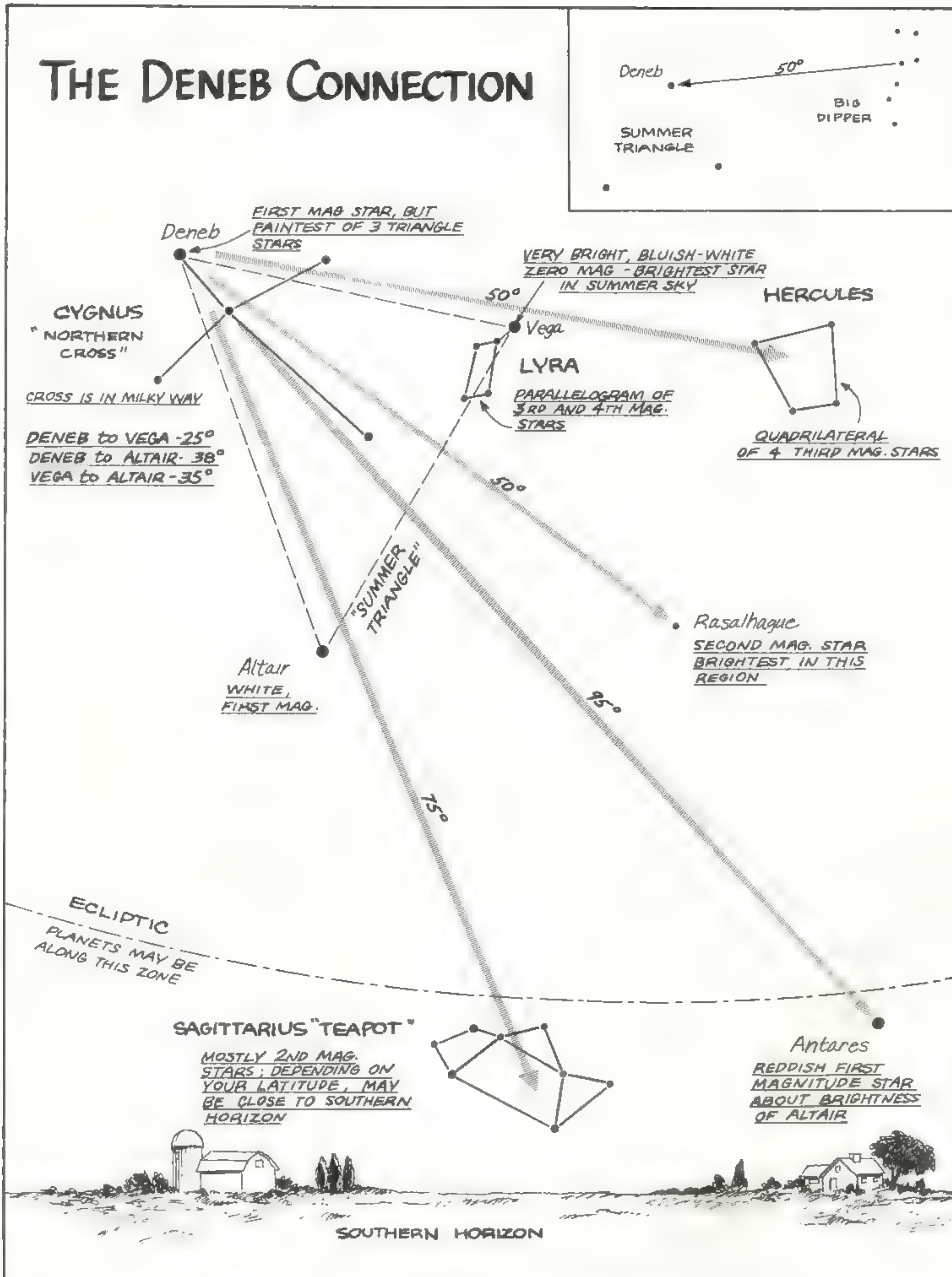
Once you have made these initial identifications using the Deneb Connection with the summer triangle, you'll want to turn to page 34 and 35 where the more detailed charts fill in the fainter stars down to magnitude 4.7. Once those identifications have been made, it becomes easy to embellish it with a more detailed chart.

On page 35 you will see that Antares is part of Scorpius, a large fishhook shaped constellation containing many second and third magnitude stars. The bottom, or most southerly portion of the fishhook is embedded in the Milky Way. This part of Scorpius is close to the southern horizon for many observers in the U.S. particularly those north of 42° north latitude.

However, the richest region of the Milky Way is the area to the northwest of the teapot. The zone is in the direction of the core of the Milky Way Galaxy. Here we are looking toward the densest regions of a mighty city of stars.

Binoculars will give you a glimpse of the magnificent aggregations of suns that litter this region. A close-up map of the whole area is shown on page 29 along with hints for telescopic examination. The Milky Way arches from the Sagittarius-Scorpius region up to Cygnus and Deneb near overhead, and northward (although somewhat dimmer) to the horizon. Because it is a nearly formless aggregation, the Milky Way is not shown on any of our charts.

THE DENEB CONNECTION



The Pegasus Connection

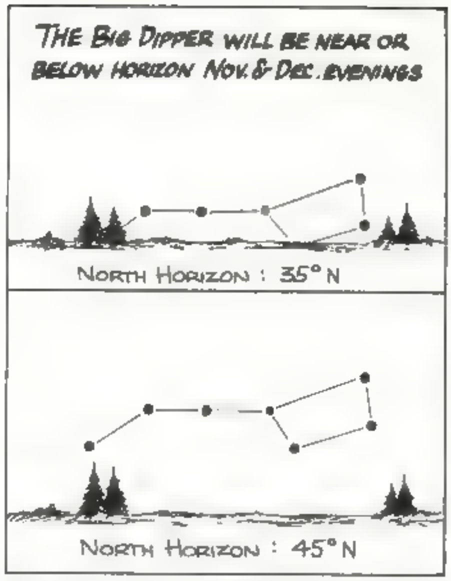
The autumn sky contains fewer bright stars than are seen at other times of the year but this is offset by the season's long evenings and comfortable observing conditions permitting leisurely investigation of a number of unique cosmic delights.

Since this sector got short-changed in the bright star department, the key to the autumn sky is centered around four second magnitude stars known as the "square" of Pegasus. Although it's not exactly a square (the sides range from 14 to 17 degrees in length) it is a distinctive stellar configuration.

The square is identified by using two of the stars in the "W" of Cassiopeia. Like the Big Dipper, Cassiopeia is well above the horizon almost all the time, and in autumn it is high in the sky serving as a perfect pointer to the center of the square. Once the square is located, Deneb can be re-identified by a simple extension of a diagonal.

To the south of the square two verticals conveniently point down to Fomalhaut, a first magnitude star in a lonely section of the sky. Diphda, a second magnitude star about the brightness of the square stars, is the brightest member of the huge constellation Cetus, the whale.

Cetus stretches off to the east (left) of Diphda and is so obscure that we have dubbed this region the "Cetus Void"—an enormous swatch of sky that contains no stars brighter than magnitude 3.2. The Cetus Void includes all the area from Diphda east to Orion and south from Hamal. The tract is not only lacking in stars but also poorly endowed with interesting objects for binoculars or telescopes.



The map on page 34 shows that the square of Pegasus is not all there is to that constellation although it's certainly the most distinctive feature in the area. Actually, the star in the northwest corner of the square (Alpheratz) is not part of Pegasus at all, but a main star in the adjoining constellation Andromeda (page 33).

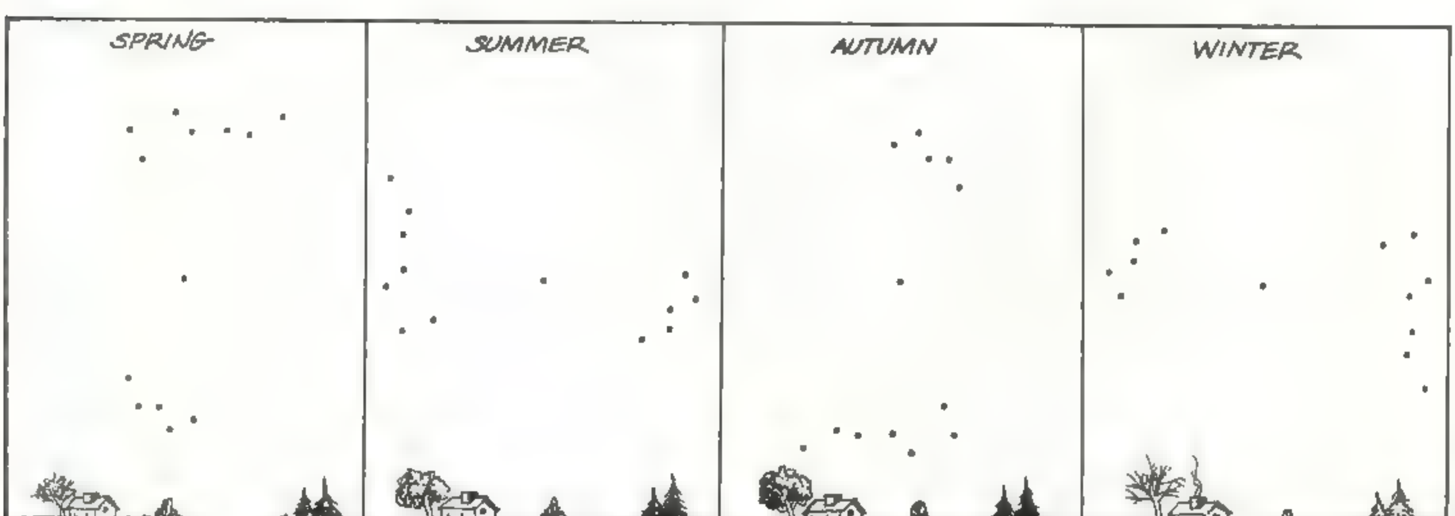
Andromeda is probably best-known for the galaxy that it contains—the only spiral galaxy like the Milky Way that is visible to the unaided eye. (Two small satellite galaxies of the Milky Way are easily seen by the unaided eye but only from south of the equator.) Using the small finder chart, (pg. 12) it should be a simple matter to locate the galaxy with unaided eyes if the sky is clear and the moon is absent.

If there is a moon, or your sky is not dark enough for you to see the Milky Way, you will have to resort to binoculars to find the galaxy. Either way the galaxy appears as a small hazy patch like an out-of-focus star.

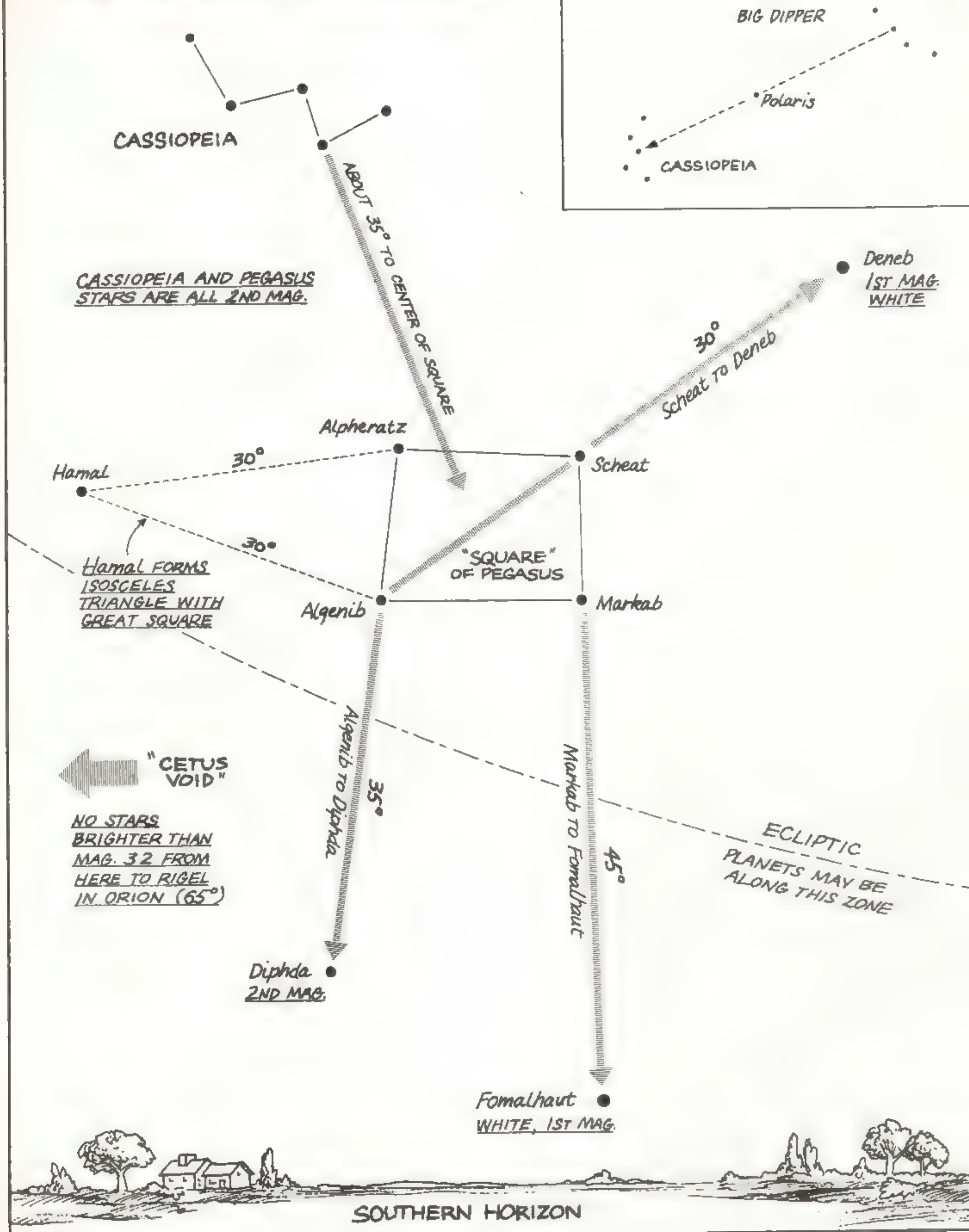
Wide-field telescopes (like the Edmund No. 2001) are probably the best instruments through which to view the galaxy because they best show its extended outer regions that form a delicate haze around a bright central nucleus.

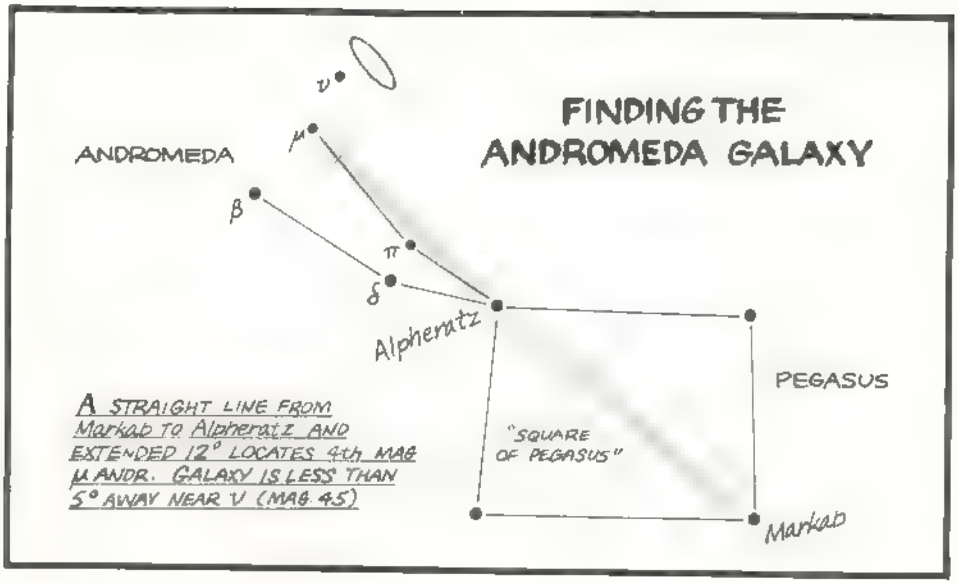
No matter how you view the galaxy you are seeing the most distant object visible to the unaided eye—a colossal swarm of at least 250 billion stars over two million light-years distant.

The Andromeda Galaxy has the same basic spiral shape as our own galaxy but is somewhat bigger than the Milky Way. While examining the hazy, subtle glow of the Andromeda Galaxy, remind yourself that the light reaching your eyes began its journey around the time of the dawn of human consciousness.



THE PEGASUS CONNECTION





The Orion Connection

If someone who is not particularly interested in astronomy is asked, "When do the stars seem brightest?" they almost invariably reply, "On a cold winter night." And this answer is correct, but not for the reasons that most people think: cold air has nothing to do with it. The winter sky is brightest because it contains more bright stars than are visible at any other time of the year.

At the heart of the winter glitter is the king of constellations, Orion. In the list of the 50 brightest stars on page 5, six of them are in Orion and of these, two are zero magnitude. Nowhere else in the sky are stars this bright clustered in such a compact or distinctive configuration. Orion stands at the center of winter's array of bright stars and the constellation naturally acts as a pointer to the stars around it. Orion is so easily identified that pointers to it hardly seem necessary.

Orion's most distinctive feature is three second magnitude stars at the center of the constellation which form a nearly horizontal row three degrees wide. The three "belt stars," as they are called, are almost instantly recognizable when you face a southerly direction any evening between Christmas and early April. As a check you can enter the Orion Connection via the Big Dipper and Capella as indicated in the small finder chart.

With the same uncanny precision in which the Big Dipper points to many of the notable stars in the sky, Orion serves to identify its own surroundings The line formed by the belt stars can be extended down and to the left to Sirius, the brightest star in the night sky. If there ever was a case of instant identification this is it since Sirius is dazzlingly superior to all the stars in this region.

Besides being the brightest star in the night sky, Sirius is also the nearest star easily visible to the unaided eye from mid-northern latitudes. Its brightness can therefore be accounted for largely by its proximity to us. However, all of Orion's bright stars are enormously distant and consequently are actually much more luminous than Sirius.

Orion seems to be a hotbed of super-brilliant stars and astronomers have linked this to the existence of a vast cloud of interstellar dust and gas that resides there. Stars are born in such clouds and the one in Orion is enormous. Part of it is illuminated by some of the newly-born stars embedded in it.

This spectacle can be seen vaguely with the unaided eye near the group of three stars south of the belt stars (see map, page 33). Nestled among these is M42 which, to the unaided eye, may look like a slightly out-of-focus star. In binoculars it appears as a distinct hazy patch and any telescope will show it to be a delicate diffuse celestial cloud, usually a pale white to most observers but some see tints of green or blue. This is the Orion Nebula, the only object of its type visible to the unaided eye. (A nebula is a diffuse cloud of gas and dust in space.)

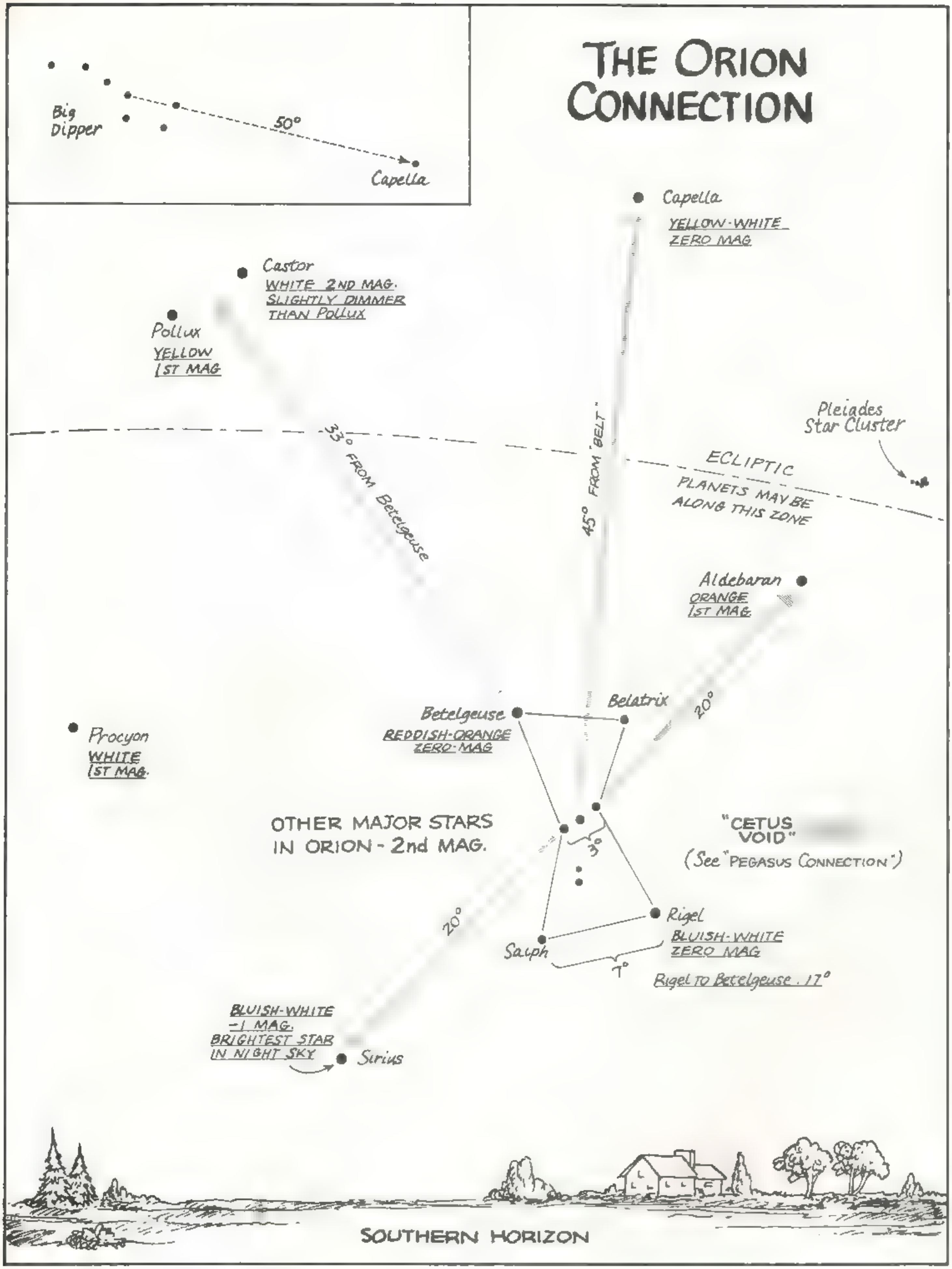
The Orion Nebula is one of the most intensely studied objects in the entire sky and astronomers have learned a great deal about stellar evolution from it.

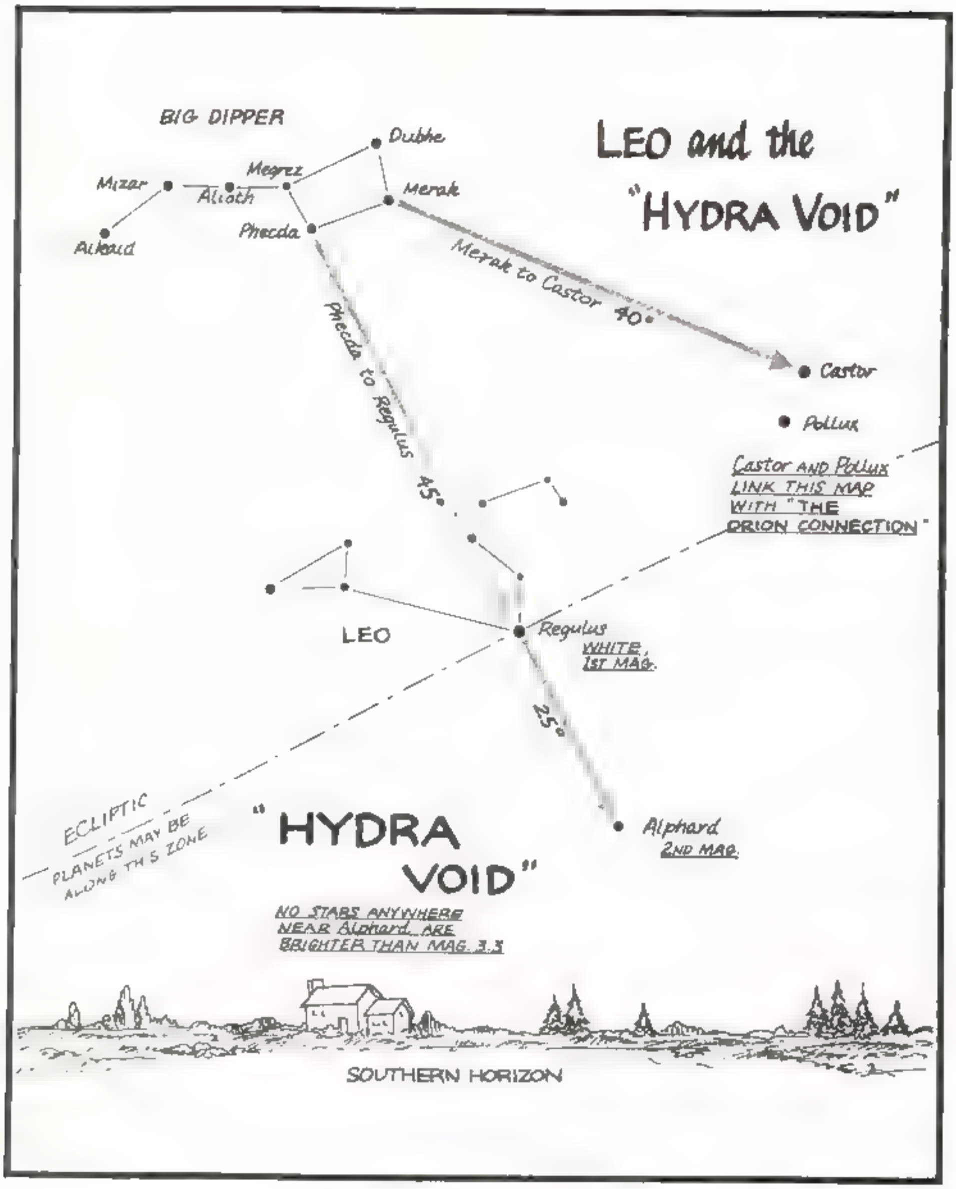
Orion's belt stars point up and to the right to Aldebaran, a first magnitude star that seems to be embedded in a swarm of third and fourth magnitude stars. In binoculars the scene looks like a crowd of insects hovering around a porch light. The group is known as the Hyades, one of the two most distinctive star clusters in the sky.

The Hyades stars are actually relatively close to one another in space so the cluster effect is not an illusion. Aldebaran, however, is not a member since it just happens to be in front of the cluster from our point of view from Earth.

The most striking star cluster in the sky is not far from the Hyades. By extending the line from the belt beyond Aldebaran you soon encounter the Pleiades, a grouping so distinctive that special instructions for its location are probably superfluous. The Pleiades consists of six stars of the third or fourth magnitude (and hundreds of fainter stars) in a compact group just over two degrees in diameter.

Often mistaken for the Little Dipper by novice skygazers, the Pleiades is much easier to identify than that rather obscure star group and certainly much more beautiful. Binoculars will reveal several dozen of the cluster's stars but the very best views of it are those through rich-field telescopes such as the Edmund No. 2001 scope.


THE ORION CONNECTION
Big Dipper
50°
Capella
Capella
YELLOW-WHITE
ZERO MAG
Castor
WHITE 2ND MAG.
SLIGHTLY DIMMER
THAN Pollux
Pollux
YELLOW
1ST MAG
Pleiades
Star Cluster
33° FROM Betelgeuse
45° FROM "BELT"
ECLIPTIC
PLANETS MAY BE
ALONG THIS ZONE
Aldebaran
ORANGE
1ST MAG.
Betelgeuse
REDDISH-ORANGE
ZERO-MAG
Belatrix
20°
Procyon
WHITE
1ST MAG.
OTHER MAJOR STARS
IN ORION - 2nd MAG.
3°
"CETUS
VOID"
(See "PEGASUS CONNECTION")
20°
Rigel
BLUISH-WHITE
ZERO MAG
Saiph
7°
Rigel to Betelgeuse . 17°
BLUISH-WHITE
-1 MAG.
BRIGHTEST STAR
IN NIGHT SKY
Sirius
SOUTHERN HORIZON



The Hydra Void

After the brilliance of the winter sky the sector of the heavens that comes into view on spring evenings seems faint by comparison. We've divided the spring skies into two zones for identification purposes—this one and the sector labeled "Follow the Arc." Both start with the Big Dipper as a reliable initial guide.

Using the two stars in the bowl closest to the handle, extend a line between them out the closed end of the bowl to first magnitude Regulus. A further extension of that line identifies second magnitude Alphard. Both of these stars are the brightest members of their constellations. Regulus lies almost exactly on the ecliptic, the planets' pathway. Occasionally a planet will seem to pass very close to Regulus providing a stunning "double star" that changes from night to night.

Turning to page 32, it becomes clear that Leo is the only significant star grouping between the Big Dipper and the southern horizon. Hence, the Hydra Void. Apart from Alphard this region is a realm of near irrelevance for the unaided eye.

Follow The Arc

This section of the sky, visible on spring and early summer evenings, again includes the Big Dipper as the primary guide with its curving handle the key to this part of the sky. That curve forms an arc (a segment of a circle) which can be extended in an imaginary line beyond the end of the dipper's handle, for about 30 degrees—the length of the entire Big Dipper.

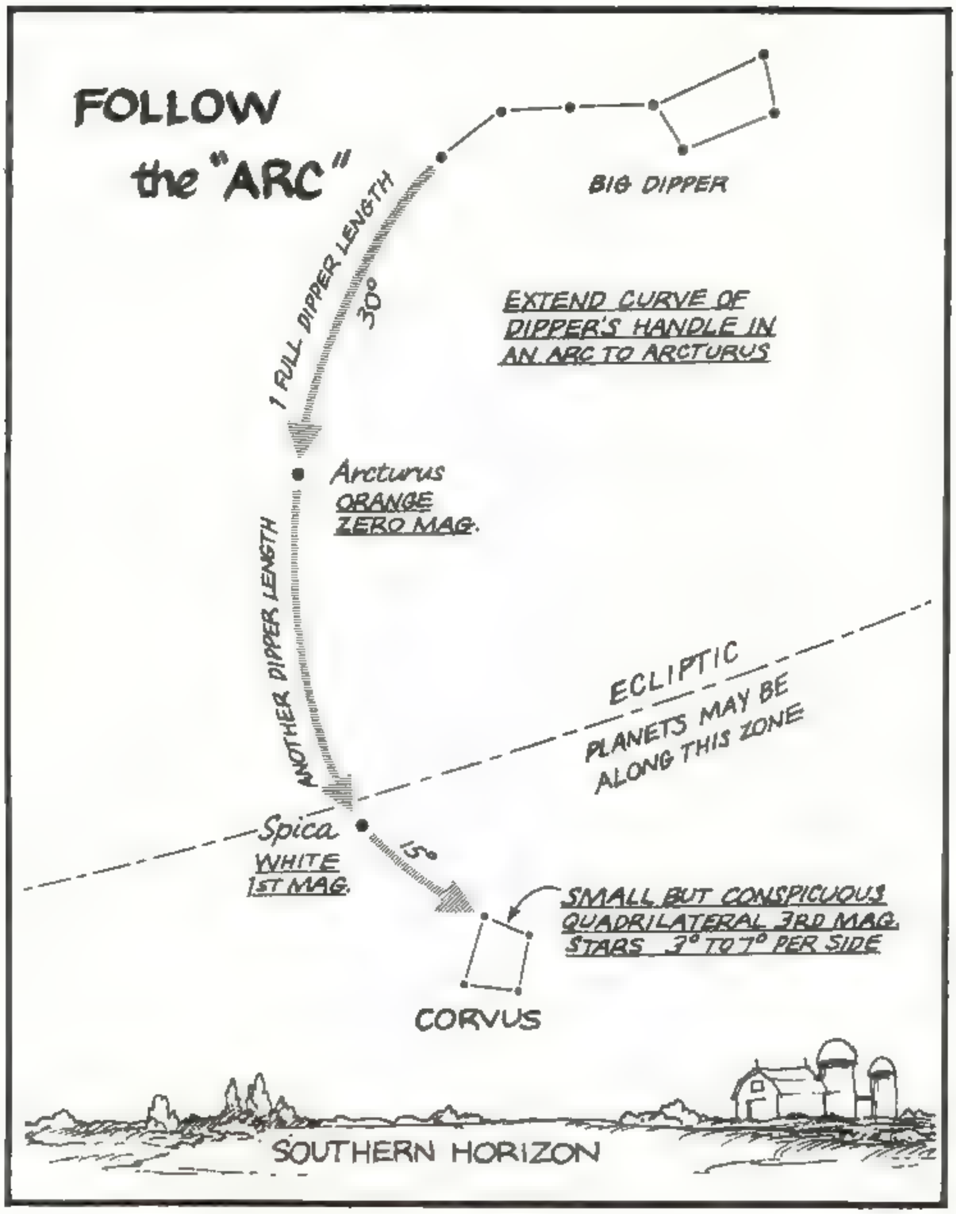
The arc leads directly to Arcturus, the second brightest star visible from north of 36 degrees latitude. Arcturus is a distinctly orangish zero magnitude star that dominates the overhead portion of the sky throughout May and June. (Thousands of amateur astronomers have remembered its name by remembering: "follow the arc to Arcturus.")

The arc continues to curve past Arcturus another 30 degrees or so to Spica, a first magnitude white star that, like Regulus, lies very close to the ecliptic and occasionally forms beautiful fake double star configurations with a planet. Both Arcturus and Spica are the brightest stars in their respective constellations of Bootes and Virgo—two large rambling constellations of third and fourth magnitude stars (see page 35).

Extending the arc past Spica by about 15 degrees identifies a distinctive quadrilateral of second and third magnitude stars forming the small constellation Corvus. Standing in a region of faint stars, Corvus by contrast to its background is an immediately recognizable grouping—there is nothing anywhere around it that can be confusing.

From Corvus west to Alphard is the Hydra Void, 45 degrees wide and extending from the southern horizon to the zenith.

These first five guide maps and descriptions introduce you to all the major stars and stellar configurations in the night sky with only a basic knowledge of sky motions and astronomical jargon. If your star gazing is limited to just that—gazing at the stars and constellations—then nothing more is needed for casual enjoyment of night's stellar canopy.



Star Names

A brief look at a star chart or a list of stars will usually turn up a plethora of star designations. Some have almost lyrical sounding names like Aldebaran or Alpheratz, while others have Greek letter designations or simply a number. Many stars have two names and a few have three, although almost always one is preferred over the others.

Most of the 50 or so brightest stars in the sky (visible from mid-northern latitudes) are known by their descriptive Arabic, Greek or Roman names. These names, although meaningless in English, usually translate into a logical word picture.

Betelgeuse, for example, is believed to be ancient Arabic for "armpit of the mighty one." Dubhe is "the back of the great bear," and Spica is "the ear of corn" in Latin. However, the majority of stars are not known by these colorful names and are simply designated by a number or letter. The first of these systems was developed by the German Johann Bayer in his star map published in 1603.

Bayer generally listed the stars in order of brightness by letters in the Greek alphabet, alpha for the brightest, beta for second brightest, gamma for third, and so on. What sometimes confuses beginners is that the constellations are not written in their normal form when used in the Bayer system but rather their genetive form. Thus the brightest star in Taurus, commonly known as Aldebaran, becomes Alpha Tauri, Elnath is Beta Tauri, and Gamma Tauri, being a fainter star, doesn't have a popular name.

Many of the big constellations contain more bright stars than the 24 letters in the Greek alphabet can accommodate. Seeking to remedy this problem the British astronomer John Flamsteed, about a century after Bayer, designated each star in a constellation with a number, thus eliminating the limiting factor in the Greek alphabet.

The numbers were applied from the western side of the constellation toward the east. In some constellations Flamsteed named more than a hundred stars as he included all he believed were within the limit of naked eye visibility. The stars Flamsteed missed are designated with catalog numbers taken from extensive lists published by observatories that specialize in star positions. Several examples are indicated on the maps.

Another naming system, common in southern hemisphere constellations, utilizes English letters which at times is confusing because some English letters look identical to some Greek letters. Modern astronomers ignore most of the English lettering system except for the use of capital letters from R to Z and double caps in all combinations to designate variable stars within a constellation. Wide double stars or strings of stars are sometimes given superscripts in the form of a small number to the upper right of the letter designations. In some of these instances the stars appear so close together that they both go by the same designation but are individually distinguished by the superscript.

Learning star designations is not difficult but it does take time to sort out all of these differences. It's like learning how to read a map for the first time.

The Visible Sky

This chart ties together all of the key stars and star groups mentioned or illustrated in the first half of the book. Those identifications provided you with an initial entry into the nightly sky show. Here the interrelationships of all the stars and constellations in the visible sky are shown. Every star and star group seen from mid-northern latitudes down to magnitude 4.0 is shown here.

In trying to put the entire sky on a single map, some distortions are bound to occur. These become most noticeable around the edge of the map where constellations have to be stretched because of the projection system used. It's the same sort of effect that makes Greenland look so large on Mercator-projected maps of the world.

In addition to being a useful guide for showing the spacial relationships between star groups, this map can be used as a planisphere (sometimes called a star-finder).

To use it in this way, turn the book so that today's date is at the bottom. The stars in the southern sky are those in the region from the date scale up to the dotted line marked "zenith circle at 40° north latitude." (The procedure works for all mid-northern latitudes.) Stars in the northern sky are those from the zenith through the north celestial pole to the dotted line marked "north horizon at 40° north latitude." The line just traced is your meridian on that date at 9 p.m. Standard Time or 10 p.m. Daylight.

The meridian is an imaginary line in the sky running from the south point up to the zenith and down to the horizon again at the north point. You will find it best to telescopically observe objects on that section of the meridian between the southern horizon and the north celestial pole since it is here that sky objects attain their highest altitude for your location.

This means you will be peering through the thinnest possible blanket of air to see them—a distinct advantage when studying objects by telescope but unimportant for the unaided eye. In summary then, by extending a line from the required date to the north pole and noting the nearby constellations you can establish what is in prime observing position.

The chart provides a second function in telling you what right ascension is in the overhead vicinity. (The R.A. is marked on the ring inside the date circle.) This is vital information because it enables you to properly make up an observing list for the evening. From

RIGHT ASCENSION AND DECLINATION

Finding the location of sky objects would be a tedious task without some kind of celestial coordinate system. A system does exist. It's the sky's counterpart to Earth's longitude and latitude.

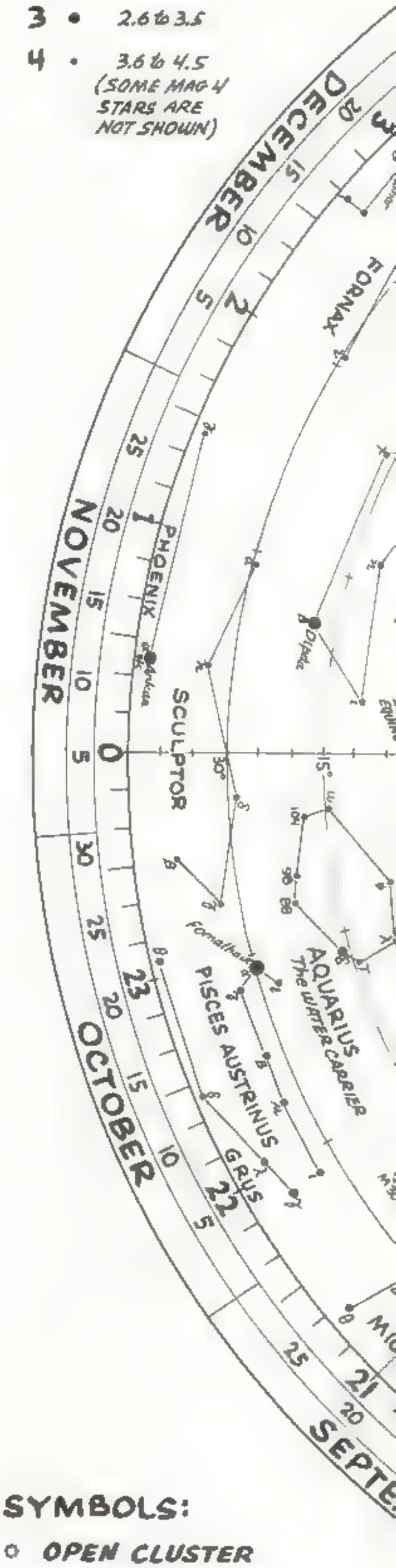
Every object has its cosmic address. For example, Vega's coordinates are right ascension 18 hours 36 minutes, declination 38.8 degrees north. This is usually abbreviated to read: R.A. 18h 36m, dec. +38.8°. Given this information it's easy to find Vega on any star map that has the coordinate system marked. Any object listed in this book can be located on one of the maps by its celestial coordinates.

The GREEK ALPHABET – Lower Case

α	β	γ	δ	ε	ζ	η	θ	ι	κ	λ	μ
Alpha	Beta	Gamma	Delta	Epsilon	Zeta	Eta	Theta	Iota	Kappa	Lambda	Mu
ν	ξ	ο	π	ρ	σ	τ	υ	φ	χ	ψ	ω
Nu	Xi (Zie)	Omicron	Pi	Rho	Sigma	Tau (Taw)	Upsilon	Phi (Fie)	Chi (Kie)	Psi (Sie)	Omega

STAR MAGNITUDES:

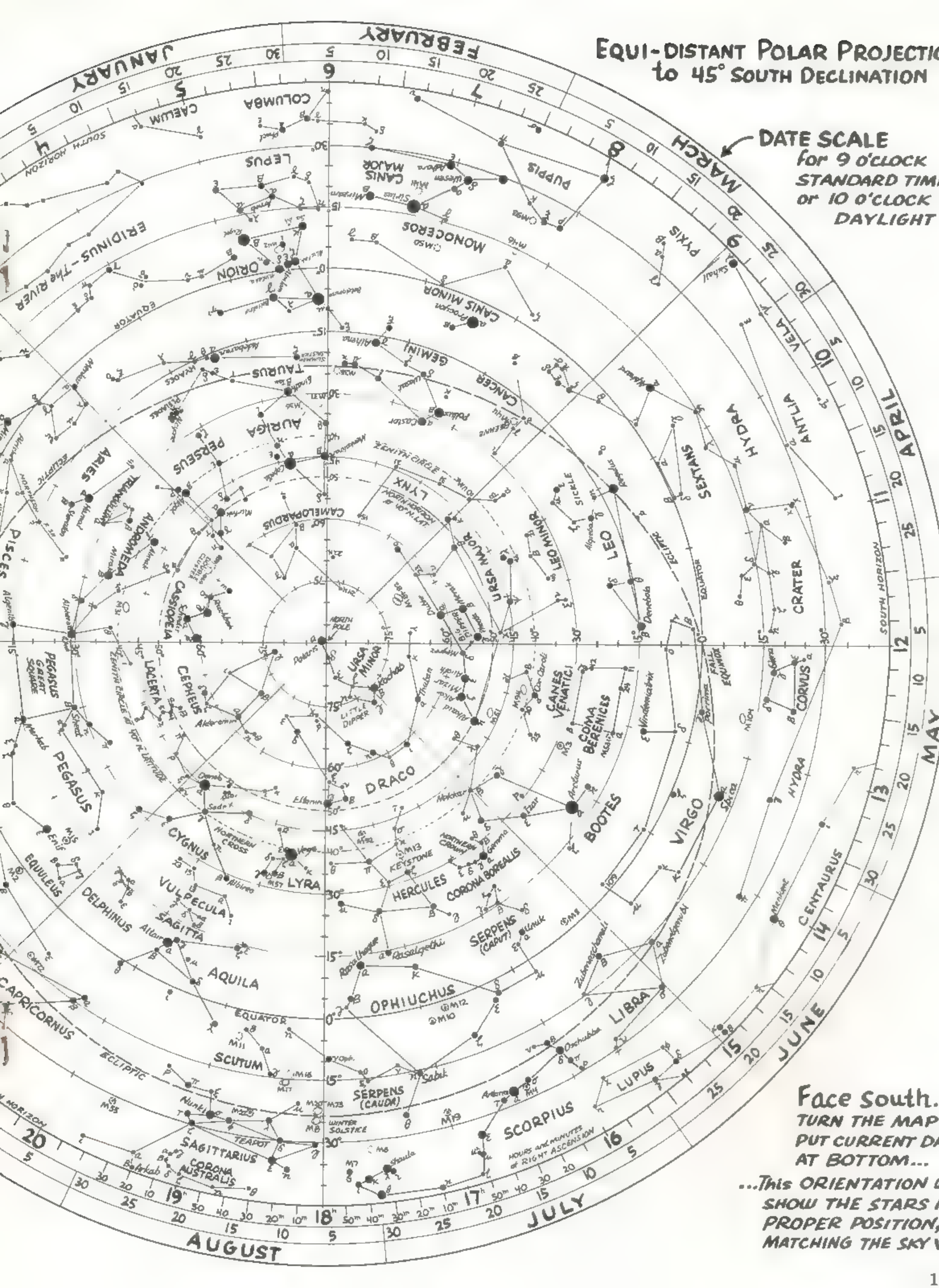
- 0 ● 0.5 OR BRIGHTER
- 1 ● 0.6 to 1.5
- 2 ■ 1.6 to 2.5
- 3 • 2.6 to 3.5
- 4 · 3.6 to 4.5 (SOME MAG 4 STARS ARE NOT SHOWN)



SYMBOLS:

- ○ OPEN CLUSTER
- ⊕ GLOBULAR CLUSTER
- ○ NEBULA (ANY OBJECT OTHER THAN STAR CLUSTERS)

Equi-distant Polar Projection to 45° South Declination



← DATE SCALE
for 9 o'clock STANDARD TIME or 10 o'clock DAYLIGHT

Face South.
TURN THE MAP TO PUT CURRENT DATE AT BOTTOM...
...This ORIENTATION WILL SHOW THE STARS IN PROPER POSITION, MATCHING THE SKY VIEW

the various tables on the following pages select objects that are within one or two hours of right ascension from the reading nearest the date. This gives you a log of observable objects for the evening.

The next step is to find these objects on the main maps at the back of the book and, using the techniques to be described shortly, find them and observe them. Remember that the sky rotates from east to west bringing areas of increasing right ascension across your meridian.

The Planets

The planets masquerade as stars. They wander across the sky invading certain constellations and can be devilishly confusing unless you watch for them. Usually one of the five planets visible to the unaided eye is up in the sky somewhere. Fortunately, planets don't roam around anywhere in the sky; there will never be one among the stars of the Big Dipper or wrecking the Northern Cross configuration of Cygnus. They stay confined to a belt in the sky called the ecliptic.

All the charts and maps in this book have the ecliptic marked warning you that if some bright object is there,it has to be a planet. All five planets visible to the unaided eye (Mercury, Venus, Mars, Jupiter and Saturn) are as bright as or brighter than first magnitude stars.

Mercury will cause little trouble since its small orbit keeps it relatively close to the sun. The planet looks like a pinkish-white first or zero magnitude star and will always be seen either in the early evening in the west just after sundown or in the east in the early morning just before sunrise. Unless you're looking for it, you will probably never see it.

Because it is brighter than the brightest stars, *Venus* is seldom confused. It is brilliant white and is always the first thing visible in the early evening or the last thing to disappear in the early morning depending on what part of the sky it is in. Venus' orbit is, like Mercury's between the sun and Earth, thus limiting the planet's visibility to no more than three hours after sunset or three hours before sunrise.

Jupiter also is brighter than any star but not as bright as Venus. Shining with a yellowish-white light, Jupiter is plainly visible in either the morning or evening sky about 10 months of each year.

Mars and *Saturn* are the problem planets since both are about the brightness of first or zero magnitude stars. Their orbits are beyond that of the Earth permitting them, like Jupiter, to be seen at various times of the night. Mars can often be distinguished by its reddish color and Saturn has a pale yellow hue.

A general rule for all the planets is that they usually do not twinkle like the stars. Stars invariably are flickering away even on the stillest nights, but unless the atmosphere is unusually turbulent the light of planets is steady.

The reason for this lies in our own atmosphere which is constantly in motion. Stars are virtual pinpoint sources, easily disturbed by the moving blanket of air. Planets, on the other hand, are actually tiny disks too small for the unaided eye to resolve, but their light, being a bigger bundle, is less susceptible to the distorting aspects of the atmosphere.

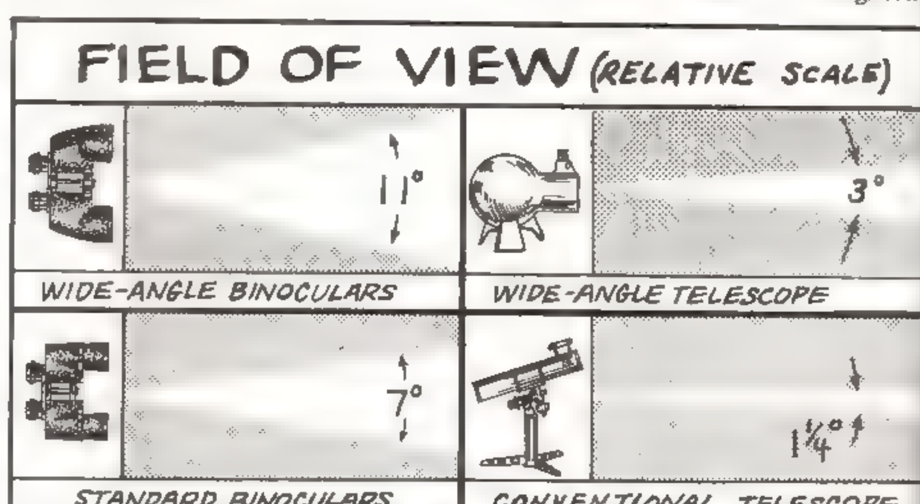
Details on where to find the planets for any date and what they look like through a telescope are given in the annual publications described on page 30.

Binoculars As Astronomical Instruments

Binoculars are simply a pair of small telescopes aligned to provide convenient viewing with two eyes. They are shorter than most telescopes because the light path is compressed by the use of prisms within the structure of the instrument. Binoculars do not transmit as much light as similar-sized telescopes designed for astronomical purposes, but make up for this in compactness and ease of use.

The largest selling binoculars are the 7 x 35 size, which means that they magnify seven times and have main objective lenses 35mm in diameter (about 1.4 inches). Thus they are approximately equivalent to a telescope with 35mm aperture and a seven power eyepiece. Although this size instrument will bring in the star fields of the Milky Way and give pleasing views of some star clusters such as the Hyades and the Pleiades, they are far out-performed by 7 x 50 binoculars.

With 50mm (2-inch) lenses 7 x 50 binoculars have double the light collecting power of 7 x 35s and will reveal stars almost a magnitude



fainter. On a clear, dark night 7 x 50 binoculars will show 9th magnitude stars.

Of course there are other combinations for binoculars: 10 x 50s are fairly common as are binoculars with larger lenses such as 20 x 60s or (less common) 20 x 70s and 12 x 80s. But there is a strong case for the 7 x 50 size. It provides the optimum balance between weight, light-collecting power, field of view, ease of handling and adaptability to other uses such as bird-watching, sporting events, etc.

Bigger binoculars are awkward to hold because of their size and weight; 20 x 60 binoculars weigh twice as much as 7 x 50s (7 x 50 binoculars usually weigh about two pounds). Large binoculars can only be conveniently used with an adapter which permits mounting on a sturdy camera tripod. Then they are fine for astronomical uses but cumbersome for other applications.

A further disadvantage with higher power binoculars is their limited field of view. With the advent of relatively inexpensive wide-field telescopes, such as the Edmund No. 2001 with its 4 inch aperture and 3 degree field, any binoculars that have a field of view of less than four degrees are enormously out-performed by the wide-field telescope with its greater light-collecting power.

All binoculars have their field of view indicated in terms of feet at a thousand yards. This can be translated into degrees of field of view—a more useful comparison for astronomical purposes. A rough guide is that 52 feet at a thousand yards is one degree.

The average 7 x 50 binoculars have a field of view of 375 feet at a thousand yards or about seven degrees—much larger than any wide-angle telescope can achieve—providing unique and comfortable sky views. On the other hand 20 x 50 binoculars with their three degree field of view actually offer a more restricted and much fainter field than the Edmund wide-field telescope.

Some binoculars, rated by their manufacturers as "wide angle" or "wide field," yield amazing picture window views up to 11 degrees wide. For astronomical purposes these wide-angle binoculars give stunning views of the Milky Way and other star-rich areas of the sky but they usually have the minor drawback of having significant portions of the outer edge of the field considerably out-of-focus due to inherent limitations of wide-angle binocular optics.

The choice here is mainly personal preference. Many amateur astronomers opt for 7 x 50 monoculars which are basically half a binocular with half the weight and lower cost than binoculars of the same aperture and magnification.

In summary then, binoculars of the 7 x 50 size get our highest recommendation because they provide a function that no telescope can duplicate and have a multitude of other uses that make them a good all-round purchase. They are only slightly more expensive than the 7 x 35 size and less expensive than higher power or larger aperture binoculars.

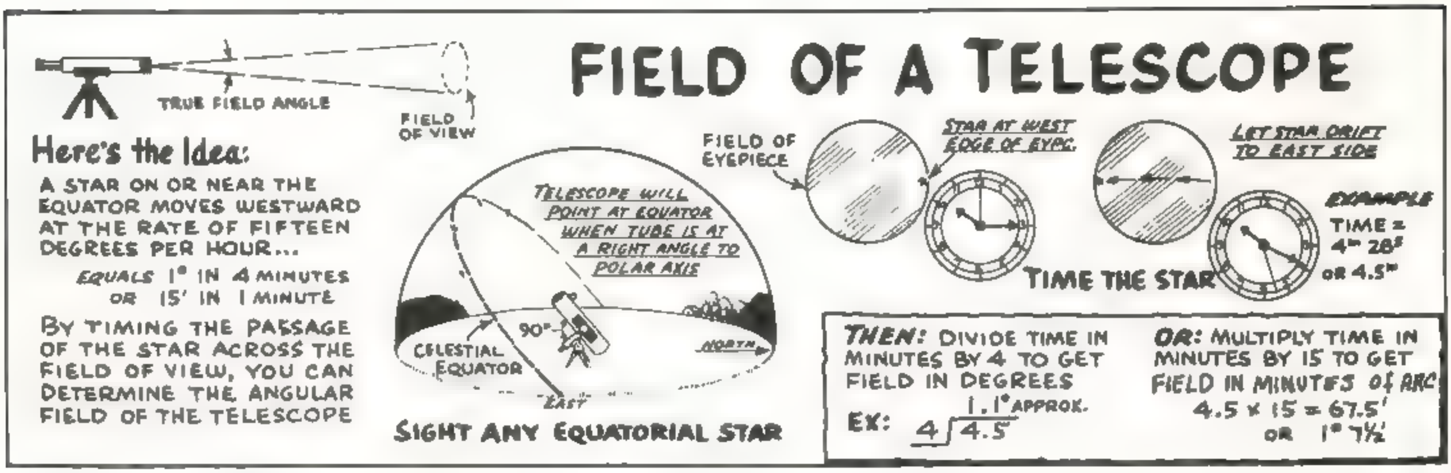
If you do select binoculars with more than 10 power, or objective lenses 60mm or more in aperture, you will also have to invest in a tripod adapter and sturdy camera tripod. Don't be misled, it is impossible to hold these bigger instruments steady for long enough periods of time for satisfactory results. In astronomy a wide-field telescope has now taken over the role once played by these larger binoculars.

Telescopes And Their Uses

Ultimately, every amateur astronomer ends up owning a telescope. Binoculars hint at the wonders to be discovered in the night sky, but only a quality telescope permits a real pursuit of the universe visible from the backyard.

TELESCOPES for AMATEUR ASTRONOMY

	REFRACTORS	NEWTONIAN REFLECTORS	CATADIOPTRIC TELESCOPES
LIGHT PATH	 MAIN LENS FOCUSES LIGHT	 PARABOLIC MIRROR COLLECTS LIGHT	
APERTURE RANGE IN COMMON USE	2-4 INCHES 60mm (2.4-inch) MOST POPULAR	3-12 INCHES 6-inch MOST POPULAR	3 INCHES and UP
FOCAL RATIOS	f/12 - f/15 MOST COMMON	f/5 - f/8 f/4 WIDE-FIELD	f/10 - f/15
ADVANTAGES	· GENERALLY MAINTENANCE FREE · AVAILABLE in SMALLER SIZES than OTHER TYPES · SHARP IMAGES to EDGE of FIELD · EXCELLENT for PLANET STUDY	· LEAST EXPENSIVE PER INCH of APERTURE · MORE COMPACT than REFRACTORS · WIDE-FIELD VERSIONS GIVE BEST POSSIBLE VIEWS of MILKY WAY and STAR CLUSTERS · EXCELLENT COLOR CORRECTION	· MOST COMPACT of ALL TYPES · IMAGES SHARP to EDGE of FIELD · USEFUL at a WIDER RANGE of MAGNIFICATIONS than OTHER TYPES
DISADVANTAGES	· RELATIVELY EXPENSIVE in APERTURES OVER 3-INCHES · LENS IMPARTS FALSE COLOR, PARTICULARLY to BRIGHT IMAGES	· UNWANTED AIR CURRENTS and DUST CAN ENTER OPEN TUBE · EDGE of FIELD of VIEW HAS OPTICAL ABERRATION CALLED COMA, ESPECIALLY in f/5 and SHORTER VERSIONS	· MORE EXPENSIVE than NEWTONIANS



The main function of an astronomical telescope is to make faint objects appear brighter; magnification is a secondary function. Light-collecting ability varies with the square of the aperture of the instrument. A telescope with a 4-inch main lens or mirror collects four times as much light as a 2-inch instrument. The incoming light is concentrated by the lens or mirror at a position convenient for viewing where it is then magnified by an eyepiece.

Telescopes that have a lens as the light-collector are called refractors and those that use a mirror for the same purpose are called reflectors. Refractors all look much the same whether large or small, but reflectors come in a variety of optical configurations, the most common by far being the Newtonian (see table).

Telescopes of a more complex design that use both lenses and mirrors are known as catadioptric telescopes. Each of these types has a minimum useful size for astronomical purposes: In refractors the 60mm (2.4-inch) size is widely in use and—if of high quality—makes a fine small telescope. Newtonian reflectors under 3-inch aperture are virtually useless for astronomy and 4-inch and 6-inch models have proven to be more popular sizes. Catadioptrics give good results in all sizes from 3-inch up.

Because telescopes are intended to be significantly more powerful than binoculars, they pay the penalty of a smaller field of view. As a general rule, increased magnification means that you see a smaller segment of the sky. Most telescopes yield their widest fields at lowest power—usually not more than 1½ degrees. This means it is frustratingly difficult to find anything in the sky with the telescope alone. A small telescope called a finderscope, mounted parallel on the side of the main scope, gets around this problem. The low-power finderscope with its four to six degree field of view and central crosshairs permits precise aiming before you look through the main instrument. Only wide-angle (sometimes called richest-field) telescopes with their 2½ to 3½ degree fields are manageable without finderscopes.

A good astronomical telescope will have at least three eyepieces providing magnifications from about 10 power per inch of aperture to about 50 power per inch. A popular trio of eyepieces on a 6-inch Newtonian reflector is, 50x, 100x and 200x. A Barlow lens, which when placed in combination with any eyepiece can double or triple its magnification, is a useful accessory.

Double And Multiple Stars

More than half of all the stars are part of double or multiple star systems—two or more stars traveling about one another in precise orbits ordained by the laws of gravity. Capella is such a star, so are Sirius and Rigel. Castor in the constellation Gemini is actually six suns intricately bound by their mutual gravitational attractions. Yet with few exceptions the unaided eye sees only single stars—the combined light of these multiple suns.

Probably the most famous multiple star in the sky, and one of the few that can be seen without a telescope, is Mizar, the star at the bend in the Big Dipper's handle. Mizar's companion, a fourth magnitude star named Alcor, can be detected less than a quarter of a degree away by anyone with average vision.

About half as far apart as Mizar and Alcor are the two components of Alpha Capricorni (known as Alpha 1 and Alpha 2 as labeled on page 34). Alpha 1 is third magnitude and Alpha 2 a magnitude fainter. If you can't distinguish them, binoculars will do the job with ease.

Tougher still are the two components of Epsilon Lyrae whose two fifth magnitude stars are only 3½ minutes of arc from each other. The fortunate few with better than average eyesight can distinguish this pair and a few other wide double stars; the remainder require telescopic aid. In each of the three cases mentioned above, the stars are orbiting one another in enormous paths requiring thousands of years for each circuit.

Such wide doubles are relatively rare. Most multiple star systems have their components as close to each other as the planets in the solar system are to our sun. Due to their vast distances from us, most star systems cannot be directly detected by any existing telescope. Astronomers have determined they exist by examining starlight spread into its component parts by a spectrograph. This method indirectly reveals the multiplicity of an apparently single star by a tell-tale shifting of lines in the resulting spectrum.

Since the majority of double and multiple star systems have their components close together so that large telescopes are incapable of directly distinguishing them, only a small percentage of such systems—the wide ones—can be discerned in telescopes commonly used by amateur astronomers. The best of these have been collected in the table on page 22.

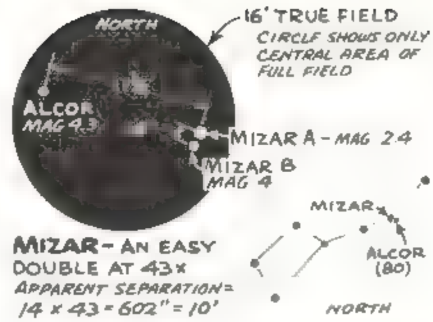
Unless you have a telescope 10 inches in aperture or larger you won't be able to see the separate components of all these star systems. But the list has been compiled with the small telescope user in mind and most of them are suitable for telescopes in the 2- to 4-inch range. In some cases a small telescope actually gives the most pleasing celestial portrait.

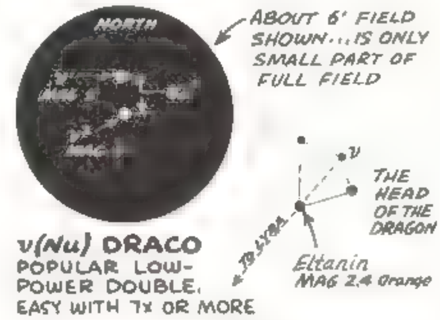
The notes accompanying each entry will act as a general guide but each column of the table has to be considered for your specific telescope, observing conditions, time of night and date, and personal experience.

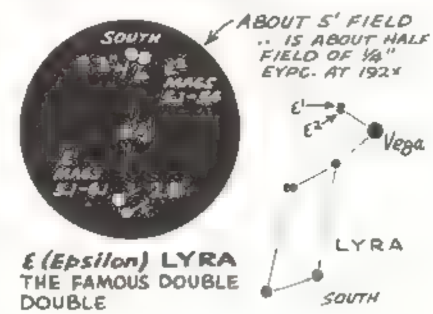
Probably the key factor is the separation of the components of the star (column labeled Sep.). Under average sky conditions a 2-inch telescope will discern two components four seconds apart, provided they are about the same brightness. A 3-inch telescope can handle separations as small as two seconds, while an 8-inch telescope will get you down into the one second separation range—again provided the two stars are approximately the same brightness. With double stars of differing brightnesses the fainter one may be lost in the glare of the brighter component.

Sirius is probably the extreme example of this brightness factor with more than eight magnitudes differences between the two stars. Although separated by 10 seconds of arc—a wide enough gap to be easily handled by any small telescope—the overpowering glare of Sirius makes the detection of the companion difficult even in larger telescopes.

For the tougher doubles like Sirius, select a still night where the stars are not violently twinkling and the target star is well up in the sky. On such nights you should be able to use 40 to 50 magnifications per inch of telescope aperture. If you can, and the star images remain tiny

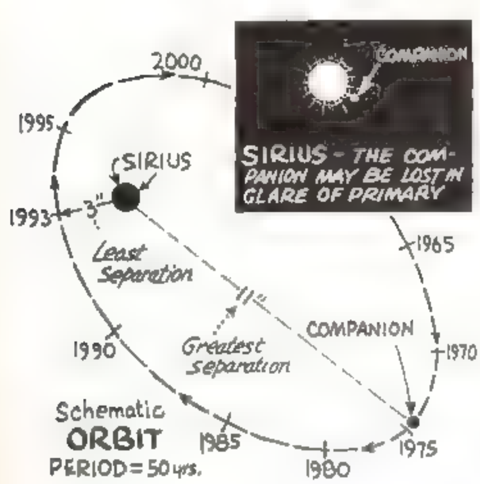


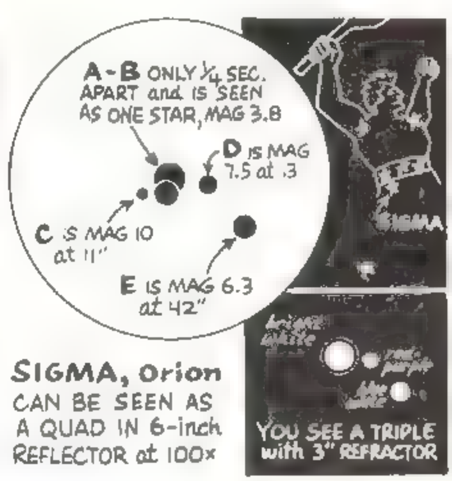


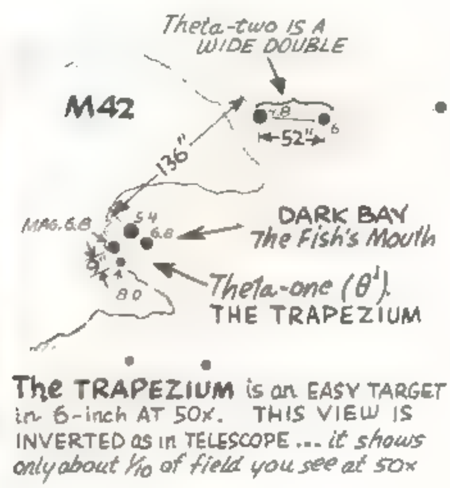


disks surrounded by a few faint concentric rings, then it's a perfect night for double star work.

However, turbulence in Earth's blanket of air often reduces stellar images to bubbly blobs that look as if you are gazing through a fishbowl at a candle flame. With experience the good nights are the ones you



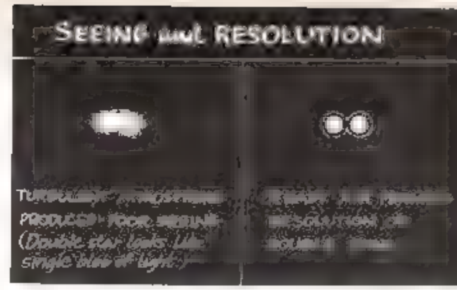




BEST DOUBLE & MULTIPLE STARS

Object	R.A. h. m.	Dec.	Mags.	Sep.	Notes
η Cas	00 47	+57.5	3½,7½	10	yellow and purple
65 Psc	00 48	+27.5	6½,6½	4.5	close matched pair
ψ Psc	01 04	+21.2	5½,6	30	easy for small scope
ζ Psc	01 11	+07.3	5½,6½	23	pale yellow & pale lilac
γ Ari	01 52	-19.0	5,5	8	stunning matched white duo
α Psc	02 00	+02.5	4½,5	2	tight
γ And	02 02	+42.2	2,5½,6½	10 0.5	orange and blue — blue star is double
α UMi	02 03	+89.2	2,9	18	Polaris, tough for small scope
ι Tri	02 11	+30.1	5½,7	4	yellow and blue
ι Cas	02 26	-67.2	5,7,8	2.5 7	tight triple
γ Cet	02 42	03.0	5,6½	3	yellow and ashen
η Per	02 48	+55.7	4,8½	28	nice color-mag contrast
θ Eri	02 57	40.5	3½,4½	8	intense white binary
32 Eri	03 53	03.1	5,6½	6	striking topaz and green pair
β Ori	05 13	08.2	0,7	9	Rigel
η Ori	05 23	02.5	3½,5	1.5	close binary both white
λ Ori	05 33	+09.0	3½,5½	4.5	yellow and purple
θ Ori	05 34	05.5	5½,7,7,8	9,14,22	Trapezium in Orion Nebula*
ι Ori	05 34	05.9	3,7½	11	miniature Rigel, beautiful field
σ Ori	05 37	02.6	4,10,7½,6½	11 13 41	colorful multiple system, triple nearby
ζ Ori	05 39	02.0	2,4,9	2.5 57	blue white binary plus third star
γ Lep	05 43	22.5	4,6½	95	pale yellow and garnet, easy
θ Aur	05 57	-37.3	2½,7½	3	nice mag contrast
ε Mon	06 22	-04.6	4½,6½	13	gold and blue
β Mon	06 27	07.0	4½,5,5½	3.7	beautiful triple
12 Lyn	06 43	-59.5	5½,6,8½	1.5 8	triple
α CMa	06 44	16.7	1½,8½	10	Sirius*
ε CMa	06 58	28.8	1½,8	7	Adhara warm-up for Sirius
α Gem	07 32	-32.0	2,3,9½	2 75	Castor, brilliant white pair
κ Pup	07 38	26.7	4½,4½	10	beautiful in small scope
ζ Cnc	08 10	+17.8	5½,6,6	1,6	close triple all yellow
ι Cnc	08 45	+29.0	4,6½	31	**orange and blue, resembles Albireo**
38 Lyn	09 16	+37.0	4,6	3	subtle colors
γ Leo	10 18	+20.2	2½,4	4.5	dazzling golden duo
54 Leo	10 54	+25.0	4½,6½	6	greenish white and blue
ξ UMa	11 17	+31.8	4½,5	2.5	white binary, 60 year period
24 Com	12 34	-18.8	5,6½	20	orange and blue-green
γ Vir	12 40	01.2	3½,3½	4	**gorgeous white pair**
α CVn	12 54	+38.6	3,5½	20	easy in small scope
ζ UMa	13 23	-55.2	2½,4	14	Mizar Alcor 12 distant*
κ Boo	14 13	+52.0	4½,6½	13	white and blue
π Boo	14 39	+16.7	5,6	6	both white
ζ Boo	14 40	+14.0	4½,4½	1	good test star
ε Boo	14 44	+27.3	2½,5	3	gold and blue beautiful
ξ Boo	14 50	+19.3	5,7	7	yellow and red
α Lib	14 50	15.8	3,5½	230	binocular pair
μ Boo	15 24	+37.6	4½,7,8	109 2	unusual triple, faint pair are orange
δ Ser	15 33	+10.7	4,5	4	both white
ζ CrB	15 39	36.8	5,6	6	easy
ξ Sco	16 03	11.3	5,5,7	1 7	tight triple with double nearby
β Sco	16 03	19.7	3,5	14	like Mizar
ν Sco	16 11	19.3	4½,6½,7,8	1 2	a double-double with pairs 42" apart
α Sco	16 27	26.4	1,6½	3	Antares with greenish companion
16-17 Dra	16 36	+53.1	5½,5½,6½	3 5 91	easy triple
α Her	17 13	+14.5	3½,5½	4	orange and blue-green, beautiful
δ Her	17 14	+24.9	3,9	10	optical pair, nice mag contrast
ο Oph	17 15	24.2	5½,7	11	orange and blue
ρ Her	17 22	+37.2	4½,5½	4	pretty white pair
ν Dra	17 32	+55.2	5,5	62	lovely white duo seen in binoculars*
ψ Dra	17 44	+72.2	5,6	30	yellow and lilac
95 Her	18 00	+21.5	5,5	6	pale red and pale green
70 Oph	18 03	+02.5	4,6	2	yellow and red — period 88 years
α Lyr	18 36	+38.8	0,10½	57	Vega
ε Lyr	18 44	-39.7	5,5½,5,6	2 3 2 7	the famous double-double*
ζ Lyr	18 44	+37.5	4,6	44	topaz and pale green
θ Ser	18 55	-04.2	4½,5½	23	both yellow-white — easy
β Cyg	19 30	+27.8	3,5½	[illegible]	**Albireo, orange and blue, superb**
δ Cyg	19 44	+45.0	3,6½	[illegible]	tight binary difficult
57 Aq	19 53	08.4	6,6½	36	contrasting subtle tints
ο Cyg	20 13	+46.6	4,5,4	107.338	wide triple — orange blue and white
α Cap	20 16	12.7	4,10½,4½,9	7,45	delicate double-double pairs 6' apart
γ De	20 45	+16.0	4½,5½	10	yellow and green, beautiful
61 Cyg	21 06	+38.5	5½,6½	28	orange binary
β Cep	21 29	+70.4	3½,8	14	unequal blue-white pair
μ Cyg	21 43	+28.5	4½,6	2	close
ξ Cep	22 03	+64.4	4½,6½	7	delicate color contrast
ζ Aqr	22 27	00.3	4½,4½	2	close white pair
δ Cep	22 28	+58.3	4 to 5,7½	41	orange and blue, primary variable
σ Cas	23 57	+55.5	5,7	3	green and blue duo

** These objects are illustrated*



will save for delicate work for separating close double stars or resolving star images at the center of globular clusters.

Surprisingly, those cold crisp winter nights are often the ones with the worst "seeing" due to large temperature differences between the ground and various levels of the atmosphere. Use nights of bad seeing for examination of the wider doubles.

If you're just beginning your excursion into the realm of double and multiple star observing start with the wide ones whose components are within three magnitudes of each other. Stars like Mizar and Albireo are not only easy with the smallest telescopes but also rank among the prettiest in the sky.

Wide-field telescopes, while not intended for high magnification, give super views of well spaced pairs at low power. Stars like Omicron in Cygnus, or the field around Vega that includes the wide doubles Epsilon and Zeta Lyrae are beautifully framed by a wide-field instrument.

Although in orbit around one another, double stars that can be seen by telescope usually do not appear to change relative to one another from one year to the next. Those where changes are visible are either nearby like Sirius and 61 Cygni, or else are close pairs like Castor.

Deep Sky Wonders

When the 18th century astronomer Charles Messier was scanning the skies in search of comets he repeatedly came across hazy objects that his telescope could not resolve into individual stars—objects that masqueraded as comets, at least in his instrument. He began compiling a list of these fixed objects so he could avoid mistaking any of them in his future searches.

Curiously, the list includes things that couldn't possibly be mistaken for comets, such as the Pleiades star cluster that is clearly a group of stars even to the naked eye. Some modern astronomers have concluded that Messier enjoyed looking at star clusters and nebulae as much as today's amateur astronomers. Whatever the reason, his list contains most of the best galaxies, nebulae, and star clusters visible in small telescopes.

Objects in Messier's catalog are designated M objects. For example, the Andromeda Galaxy is M31, the globular cluster in Hercules is M13 and the Orion Nebula is M42. Messier's list was augmented by some of his colleagues and contains 105 recognizable objects.

In compiling the Sky Guide we decided not to simply reprint Messier's list, but to select from it and other tables the very best object in each class: nebulae, star clusters, globular clusters, planetary nebulae and galaxies. Most of the objects not included in Messier's list are part of the NGC list (the New General Catalog, compiled about a century ago).

Open Clusters

Within the Milky Way Galaxy stars seem to be randomly distributed. When you look at the night sky, there are more stars in some regions than others, but no overwhelming concentrations. This impression changes when you view the sky with a telescope. There, very definitely, are certain areas where large numbers of stars are concentrated in relatively small zones of space. Many of these are recognized star clusters. The brighter members of one of these—the Pleiades—are well-seen

BEST OPEN CLUSTERS in order of Right Ascension

M	NGC	POSITION R.A.	POSITION DEC.	MAG	DIA. Min. of ARC	NUMBER OF STARS	NOTES
103	581	$1^h 32^m$	60.6°	75	5'	60	ARROW SHAPE with MAG 8 STAR AT TIP. OTHERS MAGS 10 and 11
—	752	$1^h 56^m$	37.6°	7.0	45'	70	RICH GROUP of LARGE and SMALL STARS
–	869	$2^h 17^m$	57.0°	4.5	36'	350	h PERSEUS. WEST MEMBER OF FAMOUS DOUBLE CLUSTER
—	884	$2^h 21^m$	57.0°	4.5	36	300	χ(Chi) PERSEUS IS EAST ABOUT ½°. RED and BLUE STARS
34	1039	$2^h 40^m$	42.7°	5.5	18'	80	9th MAG and FAINTER STARS, ARRANGED in PAIRS
—	1502	$4^h 05^m$	62.3°	5.5	7'	15	SMALL BUT BRIGHT
–	1528	$4^h 14^m$	51.2°	6.5	25'	60	"BRIGHT, VERY RICH, CONSIDERABLY COMPRESSED." – N.G.C DESCRIPTION
—	1746	$5^h 02^m$	23.8°	6	45'	80	BRIGHT but SCATTERED STARS
38	1912	$5^h 27^m$	35.8°	7.5	20'	100	NICE CLUSTER in a RICH FIELD
36	1960	$5^h 35^m$	34.1°	6.5	12'	60	SMALL GROUP OF MAG 9 to 11 STARS
37	2099	$5^h 51^m$	32.5°	6	20'	150	BEST OF THE THREE AURIGA CLUSTERS.. ORANGE STAR NEAR CENTER
35	2168	$6^h 07^m$	24.4°	5.5	40'	120	STARS 9 to 16 MAG
—	2244	$6^h 31^m$	4 9°	6	40'	16	CLUSTER with ROSETTE NEB AROUND YELLOW MAG 6 No. 12 MONOCEROS
—	2264	$6^h 40^m$	9.9°	4.5	30'	20	CLUSTER with CONE NEB. AROUND No. 15 MONOCEROS
41	2287	$6^h 46^m$	–20.7°	5	30'	50	A LOOSE BRIGHT CLUSTER with RED STAR at CENTER
—	2281	$6^h 48^m$	41.1°	7	15'	30	A LOOSE GROUP OF BRIGHT STARS
—	2301	$6^h 51^m$	0.5°	6	15'	60	LARGE and SMALL STARS
50	2323	$7^h 02^m$	– 8.2°	7	16'	100	RICH, COMPACT CLUSTER
—	2353	$7^h 14^m$	–10.2°	5	20'	25	INCLUDES A MAG 6 STAR
47	2422	$7^h 35^m$	–14.4°	4.5	25'	50	SEVERAL BIG STARS Scattered
46	2437	$7^h 41^m$	–14.8°	6	25'	150	RICH and UNIFORM but FAINT STARS. SMALL PLANETARY at NORTH EDGE
93	2447	$7^h 44^m$	–23.8°	6	18'	60	MAG 8 to 13 STARS in RICH FIELD
—	2477	$7^h 51^m$	–38.5°	5.5	25'	200	MAG 4, b, PUPPIS at SOUTH EDGE
48	2548	$8^h 12^m$	–5.7°	5.5	30'	80	LOOSE GROUP of 9 to 13-MAG STARS
44	2632	$8^h 39^m$	20.1°	4	90'	200	BEEHIVE CLUSTER BEAUTIFUL COLLECTION of 7th MAG and FAINTER STARS
67	2682	$8^h 50^m$	11.9°	6	15'	65	MAG 10 and FAINTER STARS in SEMI-CIRCLE
—	6124	$16^h 24^m$	–40.6°	6.5	25'	120	STARS 9 to 11 MAG
—	6383	$17^h 33^m$	–32.6°	5.5	6'	12	ALL BIG STARS, 1 DEG. WEST of M6
6	6405	$17^h 38^m$	–32.2°	5	25'	80	A JEWEL BOX of DIAMONDS MAGS 7 To 11 with a BRIGHT RUBY
7	6475	$17^h 52^m$	–34.8°	3.5	60'	80	NAKED-EYE OBJECT with MANY BRIGHT STARS - SPLASHY !
23	6494	$17^h 56^m$	–19.0°	7	25'	120	STARS MAG 10 and FAINTER
8	6523 6530	$16^h 02^m$	–24.4°	5 NEB 7 CL	20'	25	BRIGHT DIFFUSE NEBULA (LAGOON) CLUSTER and STARS THROUGHOUT
21	6531	$18^h 03^m$	–22.5°	6.5	12'	40	STARS 9 to 12 MAGNITUDE
16	6611	$18^h 17^m$	–13.8°	6.5	30'	100	HOT BLUE and WHITE STARS FORM A GLOWING NEBULOSITY
17	6618	$18^h 19^m$	–16.2°	7	25'	35	OMEGA NEBULA. CLUSTER with NEBULA, VISIBLE in any TELESCOPE
—	6633	$18^h 26^m$	6.5°	5	20'	65	MANY BRIGHT STARS, VERY LOOSE
25	—	$18^h 30^m$	–19.3°	6.5	40'	50	COLLECTION of BRIGHT and FAINT STARS
11	6705	$18^h 50^m$	–6.3°	6.5	10'	200	TIGHT CLUSTER of MAG 9 and FAINTER STARS. a real sparkler!
39	7092	$21^h 31^m$	48.2°	5	30'	25	SPARSE BUT BRIGHT
52	7654	$23^h 23^m$	61.5°	7	12'	120	MAGS 9 to 13 STARS with a MAG 8 RUBY NEAR EDGE
—	7789	$23^h 56^m$	56.5°	9.5	30'	200	FAINT but VERY RICH CLOUD of COSMIC GOLD DUST

with the unaided eye.

The true nature of the Pleiades becomes apparent when binoculars are trained on the group. Instead of the six or seven stars visible to the unaided eye, the number increases to 40 or 50. A telescope shows that the cluster contains several hundred stars. The Pleiades, and the nearby Hyades cluster, are not listed on our tabulation of best open clusters because they are so obvious.

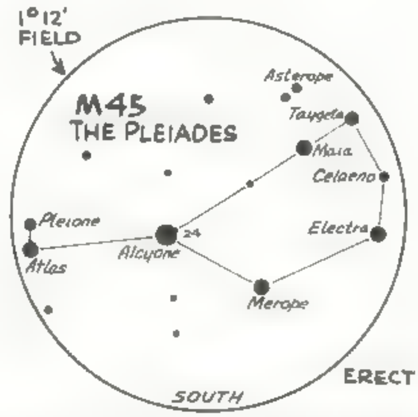
(The word open is used to distinguish these clusters from globular clusters which are more densely packed aggregations of stars.)

Some open clusters seem denser than others, some have many stars of uniform brightness, others are a combination of bright and faint stars. The variety of star clusters is only limited by the number that you choose to view. Very seldom do two look alike.

Open clusters can be viewed through any size telescope. Many are well seen in 2.4 inch refractors. A few are definitely prime material for wide-field telescopes. The 3 degree field of instruments such as the Edmund No. 2001 exquisitely frame groups such as the Double Cluster in Perseus. The Beehive Cluster (M44) in Cancer is a sprinkling of diamonds on a velvet background in such an instrument.

Every cluster listed on the table is accessible with 3-inch or larger telescopes providing a major treasure trove of celestial delicacies for the night sky explorer. Some favorites in addition to those already mentioned are M37 in Auriga, M41 in Canis Major, M7 in Scorpius and M11 in Aquila. If binoculars are your only visual aid, you should try the Beehive (M44), M39 in Cygnus, the Double Cluster in Perseus and NGC1746 in Taurus not far from the Hyades.

Open clusters are often called galactic clusters by astronomers and are believed to be loosely bound by gravitation—probably the result of a rich harvest of new stars from a condensing nebula. Most open clusters will disperse over the centuries with their stars joining the billions of other suns roaming the arms of the Milky Way.

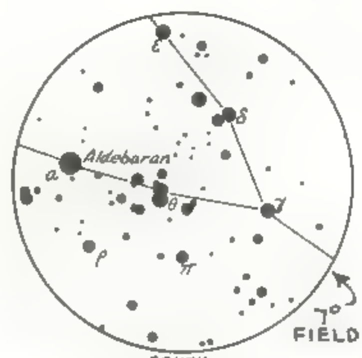


The PLEIADES – WELL-KNOWN OPEN CLUSTER MAKES A PRETTY PICTURE at 50x

THE PLEIADES (*PLEE-uh-deez*)

SEVEN SISTERS	ALCYONE	*al-SIGH-oh-nee*	3.0
	ASTEROPE	*as-TAIR-oh-pee*	5.9
	CELAENO	*seh-LEE-noe*	5.4
	ELECTRA	*eh-LEK-tra*	3.8
	MAIA	*MY-uh*	4.0
	MEROPE	*MARE-oh-pee*	4.3
	TAYGETA	*tah-IJ-ah-tah*	4.4
	PLEIONE	*plee-OH-nee*	5.1
	ATLAS	*AT-lus*	3.8

PLEIONE IS MAMA AND ATLAS IS PAPA. STAR Nº 24 (MAG 8) MAKES A WIDE DOUBLE WITH ALCYONE AT 117 SECONDS



THE HYADES – ERECT VIEW AS SEEN WITH 7x BINOCULAR (7° FIELD)

Nebulae

Scattered throughout the Milky Way Galaxy are patches of gas and dust known as nebulae. Most of these cosmic clouds are dark and diffuse and invisible in telescopes. Just a few are illuminated by stars, either embedded in them, or at their edges, providing unique vistas, like enormous puffs of smoke intertwined among the stellar jewels.

The Orion Nebula is the biggest and brightest nebula visible from mid-northern latitudes. Visible to the unaided eye as a faint haze surrounding Theta in Orion, the nebula becomes obvious even in binoculars (as described on page 12). Labeled M42 on our chart on page 33, the nebula will provide hours of interest for the user of any size telescope.

When observing the Orion Nebula—or any other faint object—be sure to select the clearest, darkest night possible. Observe away from interfering street or house lights if you can and wait until Orion is near the meridian so it will be as high in the sky as possible. If your first look through the telescope is still disappointing even under these conditions, it may be because your eyes are not yet dark adapted. It takes about 15 minutes before your eyes dilate to their fullest extent permitting the largest amount of light possible to reach the retina—the eye's image receptor.

When your eyes are fully dark adapted, you can add to their sensitivity by using a technique called averted vision. Look purposely away from the nebula to the side of the field of view and you'll notice the cloud appears more intense, with more detail. Basically the technique involves concentrating on something you are not looking at. You will be surprised at the extra detail you can see.

The nebula is brightest at the center where the multiple star Theta, also known as the Trapezium, is located (see illustration on page 21). The hot blue-white components of the Trapezium are one of the major sources of the nebula's illumination since they are embedded in it.

Although the Orion Nebula looks like an enormous billowy cloud in observatory photographs, it has a much more delicate wispy appearance in the telescope. Some observers say it appears to them to have texture rather than a hazy cloud like appearance.

The Lagoon Nebula, or M8, appears about as large, although not as bright as the Orion Nebula. Unfortunately, it is fairly close to the southern horizon (R.A. 18h03m, dec.—24.4°) and observers in the northern part of the U.S. and Canada have haze or lights on the southern horizon to contend with when observing.

Nonetheless, at sixth magnitude it is bright enough to be seen with the unaided eye under excellent conditions and any telescope will show th Lagoon as two nebulous patches with a striking cluster of several dozen stars to one side. The nebula is really a single cloud with a dark rift that makes it appear divided or lagooned, hence the name.

The Omega Nebula, sometimes called the Horseshoe or Checkmark Nebula, is shown as M17 on our charts (R.A. 18h19m, dec.—16.3°). Considerably fainter than the Lagoon or Orion nebulae, the Omega needs a 6-inch telescope for a decent view although smaller instruments will pick it up as a faint object somewhat smaller than the Lagoon.

Try a higher power eyepiece on the Omega. The higher magnification tends to darken the sky background, sometimes bringing out additional detail. Averted vision will be a help in discerning the delicate texture of the Omega. Observers who note any shape at all suggest that this nebula looks something like the number two, or a distorted checkmark, or possibly a horseshoe, accounting for its alternate names.

A few other nebulae are labeled on our charts but they are unimpressive objects in small telescopes.

Planetary Nebulae

Two centuries ago when professional astronomers were using instruments of similar size to those used by today's amateur astronomers, they occasionally stumbled across pale, approximately spherical objects that didn't look like stars but appeared to be fixed in the sky like stars. These curious entities were dubbed planetary nebulae because they present a spherical image in the telescope like a ghostly version of a planet.

The most famous planetary is the Ring Nebula in the constellation Lyra. Telescopes as small as 60mm refractors will show the 1.2 minute-wide doughnut-shaped ring between the stars Beta and Gamma in Lyra. Most of the other planetary nebulae are generally neglected by amateur astronomers even though some of them are as distinctive and as beautiful as Lyras's.

The accompanying table provides observing details.

Planetary nebulae are believed to be gas shells puffed off by stars similar to the sun but in a later stage of evolution. The Crab Nebula, or M1, is a supernova remnant and is not strictly a planetary nebula but is included in the table for convenience.

Globular Clusters

When seen under ideal conditions through a reasonably large telescope, a globular cluster can be one of the most memorable astronomical objects you will ever observe. These compact swarms of thousands of suns seemingly packed on top of one another in spherical aggregations are exceedingly distant from us—the nearest is more than 10,000 light-years away.

Globulars are not objects for telescopes under 4-inch aperture. In such instruments they appear only as hazy balls with bright cores. Although the challenge of finding the globulars with smaller instruments is reason enough to seek them out, a 6-inch or larger telescope will be needed to show the individual stars in these distant swarms.

Unfortunately, the finest globular cluster in the sky, known as Omega Centauri, is too far south to be seen except from the southern extremities of the continental United States.

Globular clusters are actually swarms of suns independent of the main body of the Milky Way. They travel in looping orbits around the nucleus of the Milky Way Galaxy.

THE Brightest PLANETARY NEBULAE

M	=NGC	POSITION R.A.	POSITION DEC.	MAG	SIZE SEC of ARC	NOTES
—	246	00^h46^m	-12.2°	8.5	210×240 (3.5×4)	BIG BUT LOW SURFACE BRIGHTNESS
—	1535	4^h13^m	-12.8°	9.5	17×20	GREYISH DISC with OUTER HALO
1	1952	5^h33^m	22.0°	8.5	240×360 (4×6)	CRAB NEBULA - IRREGULAR PEARLY WHITE - SUPERNOVA REMNANT
—	2392	7^h28^m	21.0°	8.5	43×47	PALE BLUE - BRIGHT CENTRAL STAR
—	3132	10^h06^m	40.2°	8	53×84	RIVALS RING NEB. but LOW in U.S. SKY
—	3242	10^h24^m	-18.5°	9	35×40	BLUE "GHOST OF JUPITER" BIG, BRIGHT and EASY
—	6543	17^h59^m	66.6°	9	22" DIA.	BLUE-GREEN RINGS with CENTRAL STAR
57	6720	18^h53^m	33.0°	9	59×83	RING NEBULA - LIKE a COSMIC SMOKERING!
—	6826	19^h44^m	50.5°	9	24×27	SO CALLED BLINKING PLANETARY ALTERNATE DIRECT and AVERTED VISION
27	6853	19^h59^m	22.6°	7.5	240×480 (4×8)	DUMBBELL NEBULA - LARGE PUFFY WHITE CLOUD PINCHED in MIDDLE
—	7009	21^h03^m	-11.5°	8.5	26×44	SATURN NEBULA - BRIGHT BLUE-GREEN ELLIPTICAL DISC --A COSMIC EGG!
—	7293	22^h28^m	-21.1°	6.5	720×900 (12×15')	HELIX NEBULA HUGE - NEEDS WIDE FIELD and VERY DARK NIGHT
—	7662	23^h25^m	42.4°	9	28×32	BLUE DISC - EASY

Best GLOBULAR CLUSTERS brighter than Mag. 7

M	=NGC	POSITION R.A.	POSITION DEC.	DIA. min. of arc	MAGNITUDE WHOLE	MAGNITUDE STARS	NOTES
—	5139	$13^h\ 25^m$	−47.4°	23′	4	13-15	OMEGA (ω) in CENTAURUS ... in deep South
3	5272	$13^h\ 41^m$	28.5°	10′	6.5	11-15	OVER 40,000 STARS ... VERY COMPACT
5	5904	$15^h\ 17^m$	2.2°	13′	6	11-15	40X WILL SHOW BUT NOT RESOLVE, IN SAME FIELD with No. 5 SERPENS
4	6121	$16^h\ 22^m$	−26.4°	14′	6.5	12-15	1° WEST OF ANTARES
13	6205	$16^h\ 41^m$	36.5°	10′	5.5	11-15	CENTRALLY RESOLVED with 6" at 180X
12	6218	$16^h\ 46^m$	−1.9°	9′	6.5	10-16	NEAR EQUATOR IN EXCELLENT VIEWING POSITION
10	6254	$16^h\ 56^m$	−4.1°	8′	6.5	10-15	OUTER STARS SEEN in 4"
62	6266	$17^h\ 00^s$	−30.5°	4′	6.5	14-16	FAINT ORANGE-YELLOW STARS VERY COMPACT
92	6341	$17^h\ 16^m$	43.2°	8′	6	12-15	NEARLY AS RICH AS M13 but SMALLER with TIGHT CORE
22	6656	$18^h\ 35^m$	−23.9°	17′	6	11-15	THIS and M13 RATED No. 1 for VIEWERS in U.S.—FULLY RESOLVED in 10 inch
55	6809	$19^h\ 39^m$	−31.0°	10′	6	12-15	ABOUT 20,000 LIGHT YEARS AWAY IS FAIRLY "CLOSE" for a GLOBULAR
15	7078	$21^h\ 29^m$	12.1°	7′	6	12-15	200x with 10 inch WILL RESOLVE
2	7089	$21^h\ 32^m$	−0.9°	8′	6.5	12-15	IN AQUARIUS. BRIGHT but not FULLY RESOLVED in 6-inch

Galaxies

Galaxies represent the most mind-boggling objects that nature has to offer the earthbound observer. When you gaze at a galaxy the pale misty light that barely makes an image on your eye is actually the combined light of billions of suns, millions of light-years away—far more distant than the most remote star visible by the unaided eye or telescope. Unfortunately, only a few galaxies are easily seen in small telescopes.

The Andromeda Galaxy, labeled M31 on our map, (R.A. 00h41m dec. +41.1°) is just visible to the unaided eye as a hazy patch as described on page 10. Binoculars begin to reveal what this object really is by showing its elongated shape. Like our Milky Way it is a thin disk-shaped spiral about ten times as wide as it is thick. We see it nearly edge-on so it appears elongated, about 2½ degrees wide and half a degree thick. Because of its large extent and low surface brightness, the Andromeda Galaxy is best seen in small aperture wide-field telescopes like the 4¼-inch Edmund No. 2001.

Such instruments have sufficient light collecting power over a wide enough field to contain the full extent of the galaxy and at the same time begin to show some detail. Under the best dark sky conditions, subtle, dark rifts can be seen ribbing parts of the galaxy. (This detail is only seen on the darkest of nights regardless of telescope aperture.) Through larger telescopes with narrower fields the core of the galaxy tends to take on the appearance of a bright star embedded in a celestial fog. The "fog" is the combined light of billions of unresolved stars and the point source at the galaxy's core is the most star-rich region of the stellar city. The Andromeda Galaxy has an overall total brightness equivalent to a star of magnitude 4.4.

NGC253, a galaxy seldom mentioned in observers' guides or viewed by amateur astronomers, is actually the second most easily located and observed spiral galaxy after the Andromeda Galaxy. Situated about four degrees due south of Diphda in Cetus (R.A. 00h46m dec. −25.5°) it has the same four-to-one ratio of length to width, being similarly tilted to our line of sight, as the Andromeda Galaxy. In a telescope this seventh magnitude galaxy resembles its counterpart in Andromeda on a miniature scale. Larger apertures are an advantage in observing this galaxy which appears about five minutes of arc wide and 20 in length.

M81 and M82 in Ursa Major are a pair of galaxies smaller and fainter than NGC253 but, because of their position (M81 R.A. 09h53m dec. +69.2°; M82 R.A. 09h54m dec. +69.8°) only 20 degrees from the north celestial pole and the fact that they are within two-thirds of a degree of each other, they are a favorite target for observers with 6-inch or larger telescopes.

In a 6-inch scope at low power both of the galaxies easily fit into the field of view. The eighth magnitude M81 is a spiral galaxy seen almost face-on appearing about one-quarter of a degree in diameter. The nearby ninth magnitude spindle-shaped galaxy M82 is only 10 minutes by two minutes in size. In large telescopes at low magnification these two objects make a dramatic pair on a dark, clear night. However, in telescopes under 6-inch aperture they are less than stunning. Both of these galaxies and NGC253 are about seven million light-years from Earth and constitute the most distant objects easily seen in small telescopes.

Other galaxies, although shown on the charts, are difficult to locate and distinguish with telescopes under 8-inch aperture.

Finding Telescopic Sky Objects

Various methods are used in locating sky objects with a telescope, ranging from coarse naked eye sighting along the tube to precise pinpointing with the use of setting circles. Don't expect to find the most interesting celestial sights by random sweeping. You must know exactly what you are looking for and how to get there. All methods require a good mount that doesn't vibrate unduly or have poor fittings that provide backlash or jerky motion. The importance of a telescope's mount is easily underestimated.

A good telescope mount is as important as the optics in the instrument itself. A stable mount that doesn't vibrate in the slightest breeze or jiggle wildly when you touch the focusing knob is the hallmark of a quality telescope. There are two fundamental types of mounts: altazimuth and equatorial. All telescopes have one or the other.

The altazimuth mount is commonly found on refractors under 3-inch aperture and reflectors under 4-inches and is usually less expensive than the equatorial. A proper altazimuth mount has up-and-down and left-and-right motions with locking capability and slow motion controls to allow continued manual tracking of a sky object.

Such mounts are adequate for a beginner's instrument but any amateur astronomer with a moderate intent to pursue the hobby seriously will sooner or later move up to a telescope with an equatorial mount.

The one instance where a simple altazimuth mount is preferred is on wide-field telescopes. The simple mount on the Edmund No. 2001 wide-field scope, for example, allows rapid, smooth motion in any direction. The 3 degree field is so wide, rough sighting is all that is needed.

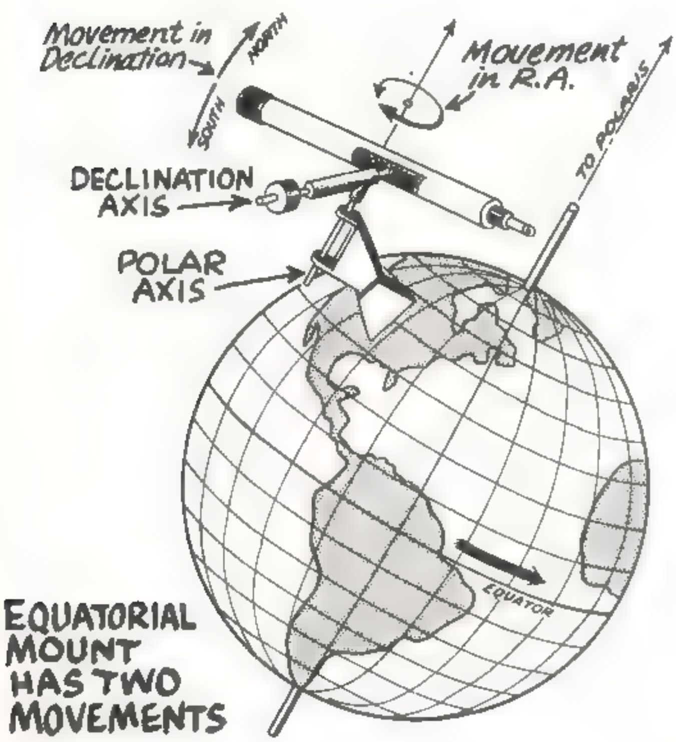
Finding sky objects with an altazimuth mounted instrument can only be accomplished by the "star-hop" method, which works for most objects sought with small instruments. For example, suppose you wanted to examine the star cluster M39. The celestial coordinates tell you it is located not far from Deneb (see map page 34). A star-hop from Deneb to M39 is the procedure. Begin by centering Deneb in the finderscope's field of view, then move east (left) towards Xi Cygni, a fourth magnitude star. Continue to Rho Cygni, another fourth magnitude star, and then to Pi 2, the third star of fourth magnitude in the chain.

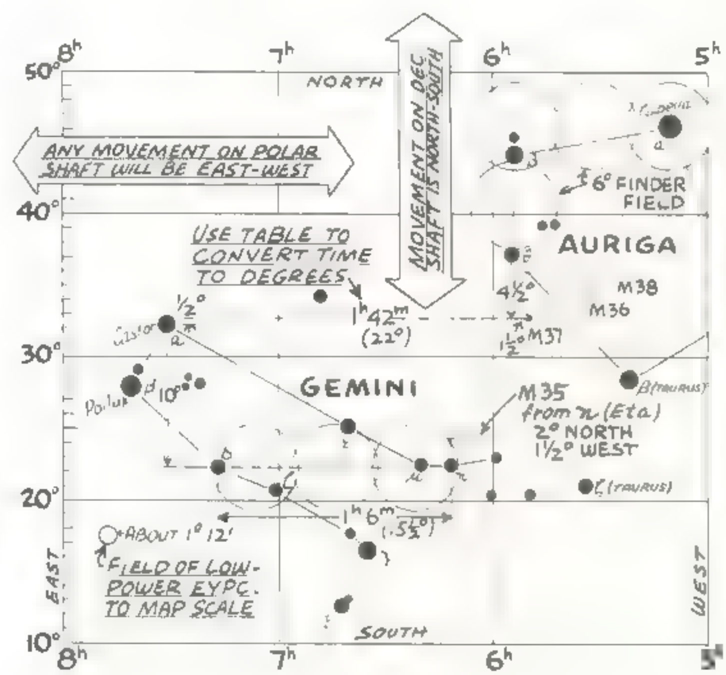
These stars will be readily apparent in your finder and since each is less than five degrees from its nearest neighbor the finder will contain two at a time allowing star-hopping from one to the next. M39 forms a triangle between Rho and Pi 2 and centering the finder on this spot will bring the object into view in the main telescope.

This system begins to break down when you search for objects that are beyond a finderscope field from an easily recognizable third or fourth magnitude star. But owners of altazimuth mounted telescopes should realize that this is one of the limitations of these less expensive pieces of equipment.

An equatorial mount, being specifically designed for astronomical use, has many advantages over the altazimuth. When properly set up, the equatorial mount's polar axis will point toward the north celestial pole. For most observing situations accuracy within a degree or two is good enough. This can be done by "eyeballing" along the polar axis toward Polaris, or by sighting down the telescope tube when it is parallel to the polar axis.

Once the desired object is located in the main telescope, the motion of the Earth's rotation can





RIGHT ANGLE SWEEPS IN AURIGA and GEMINI....*Rectangular coordinates simplify plotting* be compensated by the rotation of the polar axis which is parallel to the Earth's axis. The polar axis turns in the opposite direction to the Earth's rotation to keep the sky object centered in the telescope. This turning is accomplished by either a manual slow-motion control attached to the polar axis through a worm gear or, better still, by a motor drive mechanism that leaves the observer free to devote his attention to the object under observation while the motor compensates for the Earth's rotation.

The major hurtle for most beginning amateur astronomers is *finding* the object to be observed. The procedure described for an altazimuth mount can be used—and often is used—by owners of equatorials. But the equatorial mount's advantage is double barreled. It has a built-in dial-a-star system that makes use of the numbered dials, called setting circles, on both axes, and it is oriented parallel to the sky coordinate system making celestial sleuthing much easier.

Whether or not your equatorial mount has setting circles, you can use the right angle sweep method. This is a very practical method for use with an equatorial since the natural motion of this type of mount is either north-south or east-west. That is, motion in right ascension and declination—these being at right angles in all parts of the sky.

The idea is to begin with a bright guide star and move first in right ascension or declination, then make a right angle turn moving a specified direction on the other axis to reach the desired sky object. You can tell how far you've moved in each direction by noting how many finderscope fields you sweep through.

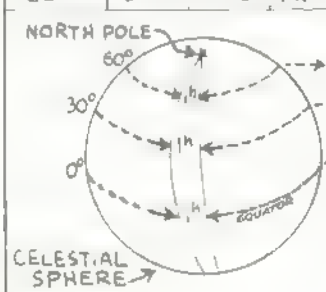
You can determine the diameter of your finder's field of view by using the same method used for an eyepiece field of view as described in the box at the top of page 20. Most finders have five or six degree fields.

Let's take a test object to see how the system works.

From the double star table on page 22 we select the star 32 in Eridanus (abbreviated to 32 Eri) at R.A. 3h53m, dec.—3.1°. Since this star is in a dim section of the sky, as shown on the map on page 33, we would probably want to start from a nearby but easily

EYEPIECE ANGULAR SIZE *from an* INTERVAL *of* STAR-DRIFT TIME

TIME INTERVAL	DECLINATION OF OBJECT – NORTH OR SOUTH															
	0°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°
1m	.25°	.24°	24°	.23°	.22°	.21°	.20°	.19°	.17°	.16°	.14°	.12°	.10°	.08°	.06°	.04°
2m	.50	.49	.48	.47	.45	.43	.41°	.38	.35	.32	.28	25	.21	.17	.13	.08
3m	.75	.73	.72	.70	.67	.64	.61	.57	.52	.48	.42	.37	.31	.25	.19	.12
4m	..00	.99	.97	.94	91	.87	.82	.77	.71	.64	.57	.50	.42	.34	.26	.17
5m	1.25	1.23	1.21	1.17	1.13	1.08	1.03	.95	.88	.80	.72	.62	.53	.42	.32	.21
10m	2.50	2.46	2.41	2.35	2.26	2.16	2.05	1.91	1.76	1.60	1.44	1.25	1.05	.85	.64	.43
15m	3.75	3.69	3.62	3.52	3.39	3.24	3.07	2.86	2.65	2.40	2.15	1.87	1.59	1.27	.97	.64
20m	5.00	4.94	4.83	4.70	4.53	4.33	4.09	3.83	3.53	3.21	2.87	2.50	2.11	1.71	1.29	.87
25m	6.25	6.17	6.04	5.87	5.66	5.41	5.12	4.78	4.41	4.01	3.58	3.12	2.64	2.13	1.61	1.08
30m	7.50	7.39	7.24	7.05	6.79	6.49	6.14	5.74	5.30	4.82	4.30	3.75	3.17	2.56	1.94	1.30
35m	8.75	8.62	8.45	8.22	7.92	7.57	7.17	6.69	6.18	5.62	5.02	4.37	3.70	2.98	2.26	1.51
40m	10.00	9.85	9.66	9.40	9.06	8.66	8.19	7.66	7.07	6.43	5.74	5.00	4.23	3.42	2.59	1.74
45m	11.25	11.08	10.87	10.57	10.19	9.74	9.22	8.61	7.95	7.23	6.46	5.62	4.76	3.84	2.91	1.95
50m	12.50	12.31	12.07	11.75	11.32	10.80	10.23	9.50	8.83	8.00	7.17	6.20	5.28	4.20	3.23	2.10
55m	13.75	13.54	13.28	12.92	12.45	11.88	11.26	10.45	9.71	8.80	7.89	6.82	5.81	4.62	3.55	2.31
60m	15.00	14.78	14.49	14.10	13.59	12.99	12.28	11.49	10.60	9.64	8.61	7.50	6.34	5.13	3.88	2.61



From TABLE ABOVE

1h AT 60° DEC. = 7½°

1h AT 30° DEC. = 13°

1h AT 0° DEC. = 15°

TIME UNITS NOT LISTED CAN BE OBTAINED BY ADDING
EX.- 8m TIME. *ADD TABULATED VALUES FOR 5m AND 3m*

Problem: FIND ANGULAR DISTANCE from STAR **CASTOR** to **M37** *(See drawing at top)*

Solution: R.A. CASTOR – 7h 33m = 6h 93m
Subtract R.A. M37 5h 50m 5h 50m
Time Interval 1h 43m

ADD from TABLE at 30° DEC.
1h = 12.99°
40m = 8.66°
3m = .64°
22.29° *ANGULAR DISTANCE*

22¼°

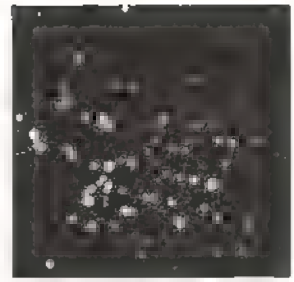
identifiable star like Rigel in Orion.

Using the table on page 5 we see that Rigel's position is R.A. 5h13m, dec.—8.3°. A simple calculation shows that 32 Eri is 1 hour and 20 minutes west (page 31) and 5.2 degrees north of Rigel.

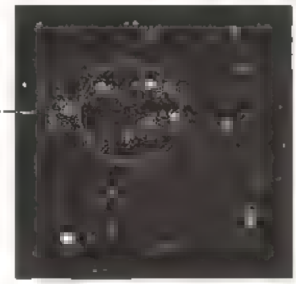
To convert the right ascension figure to degrees, use the table (pg. 28). In this instance 1 hour and 20 minutes at 10 degrees south declination gives us just under 20 degrees. So, setting the telescope with Rigel in the center of the field, sweep 20 degrees west then 5 degrees north and 32 Eri should be at least in the finder field of view if not in the main telescope, depending on the precision of your mount and alignment on the north celestial pole.

As noted earlier this method does not require setting circles. You can space off the distance by field widths. If your finder field is 6 degrees in diameter move Rigel to the side of the field and continue westward by moving a star on the opposite side of the field from Rigel to the edge of the field and so on in five degree "hops."

Four finder fields would give the required 20 degrees and one field north would get the star 32 Eri in the finder field. The same



M6 - The JEWEL BOX SPARKLES LIKE DIAMONDS IN ANY TELESCOPE. South is up in this inverted view

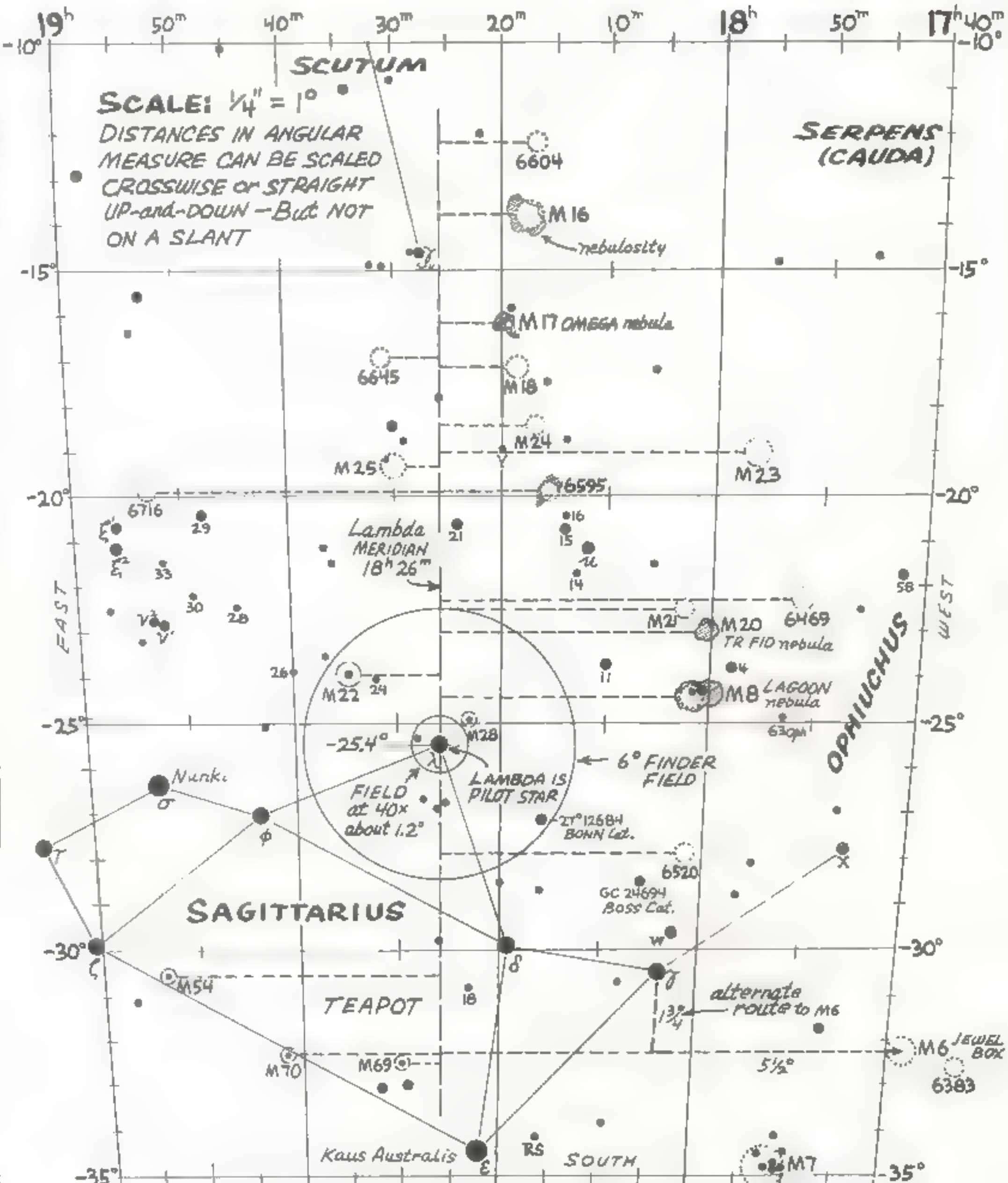


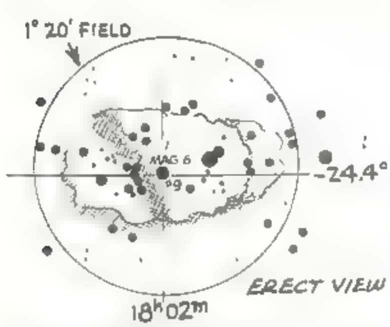
M25 WAS DESCRIBED BY MESSIER AS 10' DIA., but WIDER FIELDS UP TO 40' OF ARC ARE USUALLY SPECIFIED

RIGHT-ANGLE SWEEPS from LAMBDA, SAGITTARIUS

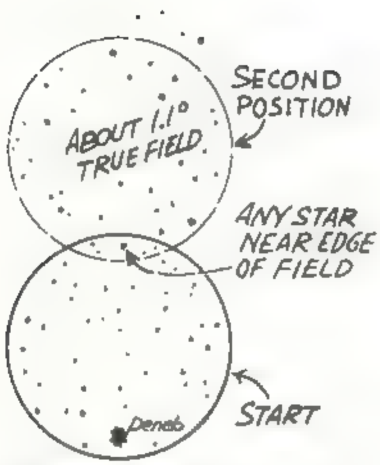
OBJECT		DISTANCE		TOTAL MAG.
M [1]	=RNGC [2]	EAST or WEST	NORTH or SOUTH	
M6	6405	10° W.	6¾° S.	5
M8	6523	5½° W.	1° N.	5
M16	6611	2° W.	11¾° N.	6.5
M17	6618	1½° W.	9¼° N.	7
M18	6613	1¾° W.	8¼° N.	8
M20	6514	6° W.	2½° N.	5
M21	6537	5¼° W.	3° N.	6.5
M22	6656	2° E.	1½° N.	6.5
M23	6494	7° W.	6½° N.	7
M24	6603	2° W.	7° N.	6
M25	NOT LISTED	1° E.	6° N	6.5
—	6595	2½° W.	5½° N.	7
—	6604	2¼° W.	13¼° N.	8
—	6645	1¼° E.	8½° N.	8.5
—	6716	6½° E.	5½° N.	7

[1] MESSIER Catalog
[2] REVISED NEW GENERAL Catalog





M8 - LAGOON NEBULA IS A FINE SIGHT IN 6-inch REFLECTOR AT 40x



STEPPING OFF 1° with EYEPIECE FIELD

procedure can be accomplished with the lowest power telescope eyepiece as shown in the diagram. This method is generally more accurate because the telescope field is usually more littered with stars than the finderscope field.

If your equatorial mount does have setting circles then the procedure is much easier. You simply move the 1 hour 20 minutes to the west using the increments marked on your R.A. circle and then 5.2 degrees north which also will be clearly marked on the declination circle. You're there!

It is obvious that the best-equipped telescope—one with an equatorial mount and accurate setting circles—is actually the easiest to use to find the more difficult sky objects. In using this system, however, you don't have to worry about the setting circles coinciding with the actual right ascension and declination of the objects that you are looking at—you are only using them for the *difference between the coordinates* of the two objects.

With the tables in this book you can make up your night's observing list before you go outside by selecting the objects you wish to examine, designating pilot stars for them and making yourself a table of right ascension and declination right angle sweeps from the pilot star.

An alternate method for making up an observing list is to scale directly on the maps. Just measure directly, but only horizontally or vertically, the distances in hours and minutes right ascension and degrees declination. If you use the field of view sweep method rather than setting circles, convert the R.A. to degrees by using the table.

Probably the most useful pilot star in the whole sky is Lambda Scorpii, shown on the chart on page 29. This star is centrally located in the sky's richest region for deep sky wonders.

Additional Reading

The Edmund Mag 5 Star Atlas by Sam Brown. (Edmund Scientific Co.). Similar in size and format to the book you are now reading, the Mag 5 Star Atlas has more detailed charts and descriptions of some additional objects. The Edmund Sky Guide and the Mag 5 Star Atlas were written to complement each other and together form a good practical reference package for the amateur astronomer.

All About Telescopes by Sam Brown, (Edmund Scientific Co.). This 192-page book is probably the most useful practical guide to telescope making, telescope optics and telescope use ever written. Sam Brown spared no details when describing mirror grinding and testing, building your own telescope, astrophotography, how to use an equatorial mount, and much more. Profusely illustrated with diagrams, tables and sketches.

The Astronomical Calendar by Guy Ottewell, (published annually by the Dept. of Physics, Furman University, Greenville, S.C., 29613). This large format guidebook gives positions of the planets for the whole year, details of meteor showers, finder charts for comets and asteroids, and much more. Highly recommended.

The Observer's Handbook, edited by John R. Percy, (published annually by The Royal Astronomical Society of Canada, 124 Merton St., Toronto M4S 2Z2). Although similar in purpose to the Astronomical Calendar, this 120-page volume has many informative reference tables and charts that are not contained in that work. Excellent value.

Sky Maps

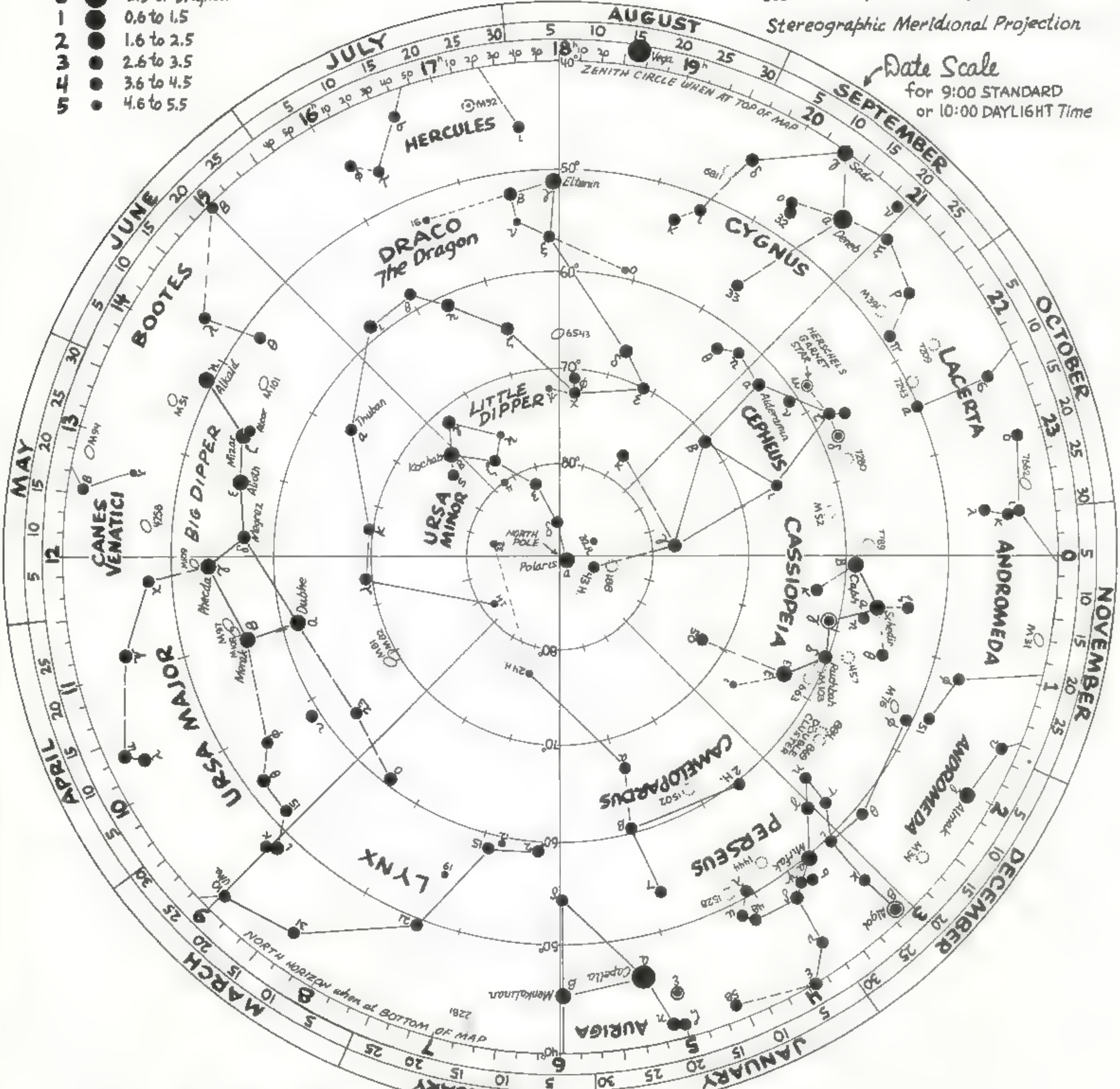
STAR MAGNITUDES:

- 0 — 0.5 or brighter
- 1 — 0.6 to 1.5
- 2 — 1.6 to 2.5
- 3 — 2.6 to 3.5
- 4 — 3.6 to 4.5
- 5 — 4.6 to 5.5

NORTH CIRCUMPOLAR at 40° North Latitude

Stereographic Meridional Projection

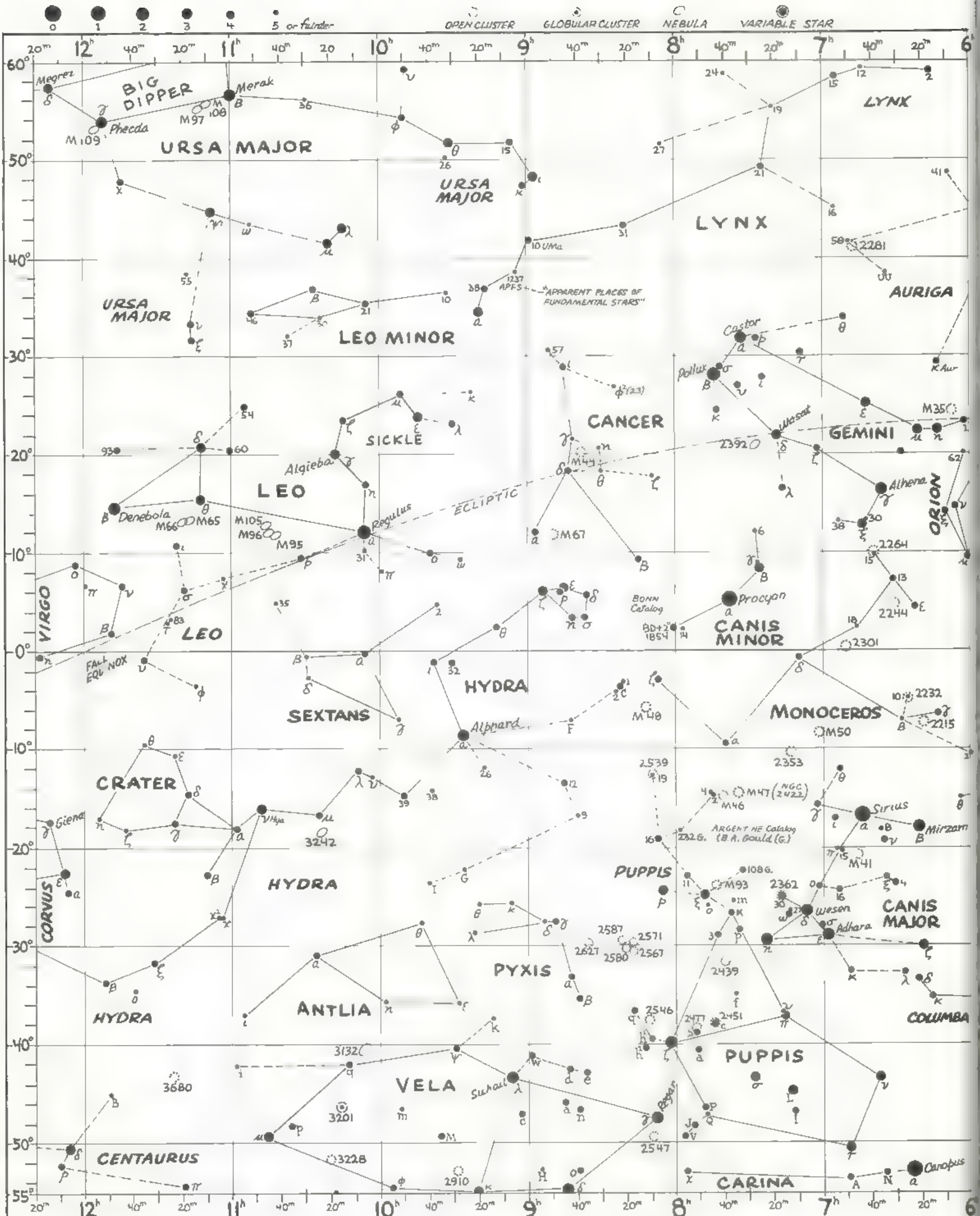
Date Scale for 9:00 STANDARD or 10:00 DAYLIGHT Time



How to Use This Map:

FACE NORTH. *TURN* THE MAP AROUND TO PUT THE CURRENT DATE AT THE **TOP.**
Then, FOR 9 O'CLOCK STANDARD TIME or 10 O'CLOCK DAYLIGHT TIME, READ THE APPROXIMATE RIGHT ASCENSION IN HOURS and MINUTES OPPOSITE THE DATE. THIS IS YOUR MERIDIAN — your NORTH-SOUTH LINE IN THE SKY. THE TOP HALF OF THE MAP WILL SHOW STARS FROM THE NORTH POLE TO YOUR ZENITH; the BOTTOM HALF WILL SHOW STARS FROM POLARIS TO YOUR NORTH HORIZON.

for a LATER TIME:
DETERMINE THE AMOUNT OF TIME YOU ARE PAST MAP TIME OF 9 O'CLOCK STANDARD TIME or 10 O'CLOCK DAYLIGHT. PROCEED AS BEFORE and then ADD THE ELAPSED TIME TO LOCATE THE GREATER R.A. ON YOUR MERIDIAN.


0 1 2 3 4 5 or fainter
OPEN CLUSTER
GLOBULAR CLUSTER
NEBULA
VARIABLE STAR
BIG DIPPER
Megrez
Merak
Phecda
M97
M108
M109
URSA MAJOR
URSA MAJOR
URSA MAJOR
LYNX
LYNX
10 UMa
1237 APFS
"APPARENT PLACES OF FUNDAMENTAL STARS"
AURIGA
LEO MINOR
Castor
Pollux
CANCER
M44
M67
GEMINI
Wasat
Alhena
ORION
M35
2281
2392
SICKLE
Algieba
LEO
Denebola
M66
M65
M105
M96
M95
Regulus
ECLIPTIC
VIRGO
LEO
FALL EQUINOX
BONN Catalog
BD+2° 1854
Procyon
CANIS MINOR
2264
2244
2301
HYDRA
SEXTANS
Alphard
M48
MONOCEROS
M50
2232
2215
2353
2539
M47 (NGC 2422)
M46
CRATER
Giena
CORVUS
HYDRA
3242
ARGENT NE Catalog (B. A. Gould (G.)
Sirius
Mirzam
M41
PUPPIS
M93
2362
Wesen
Adhara
CANIS MAJOR
2587
2571
2567
2627
2580
PYXIS
2439
ANTLIA
HYDRA
2546
2477
2451
COLUMBA
3132
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VELA
Suhail
PUPPIS
3201
Regor
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CENTAURUS
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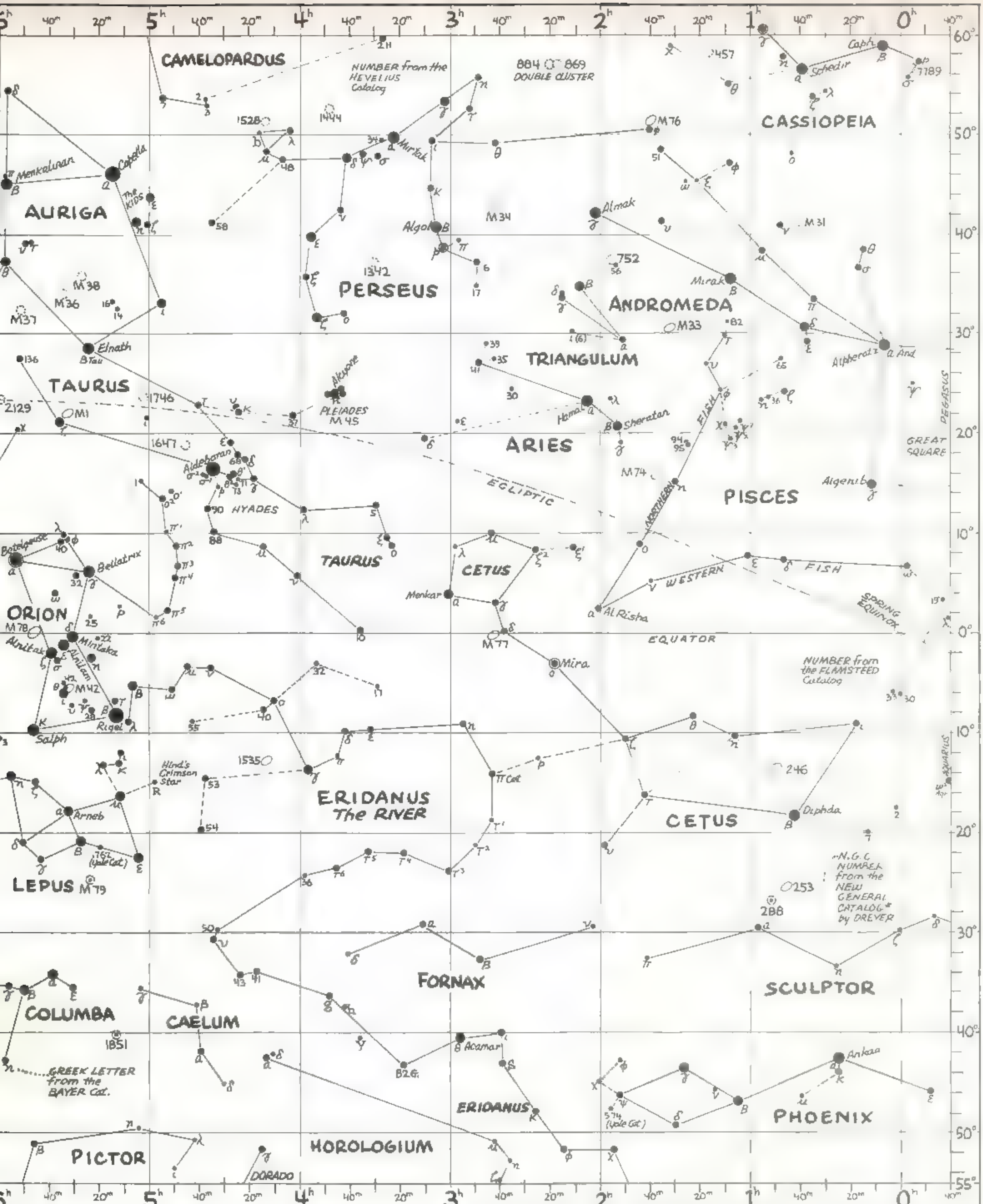
2910
CARINA
Canopus



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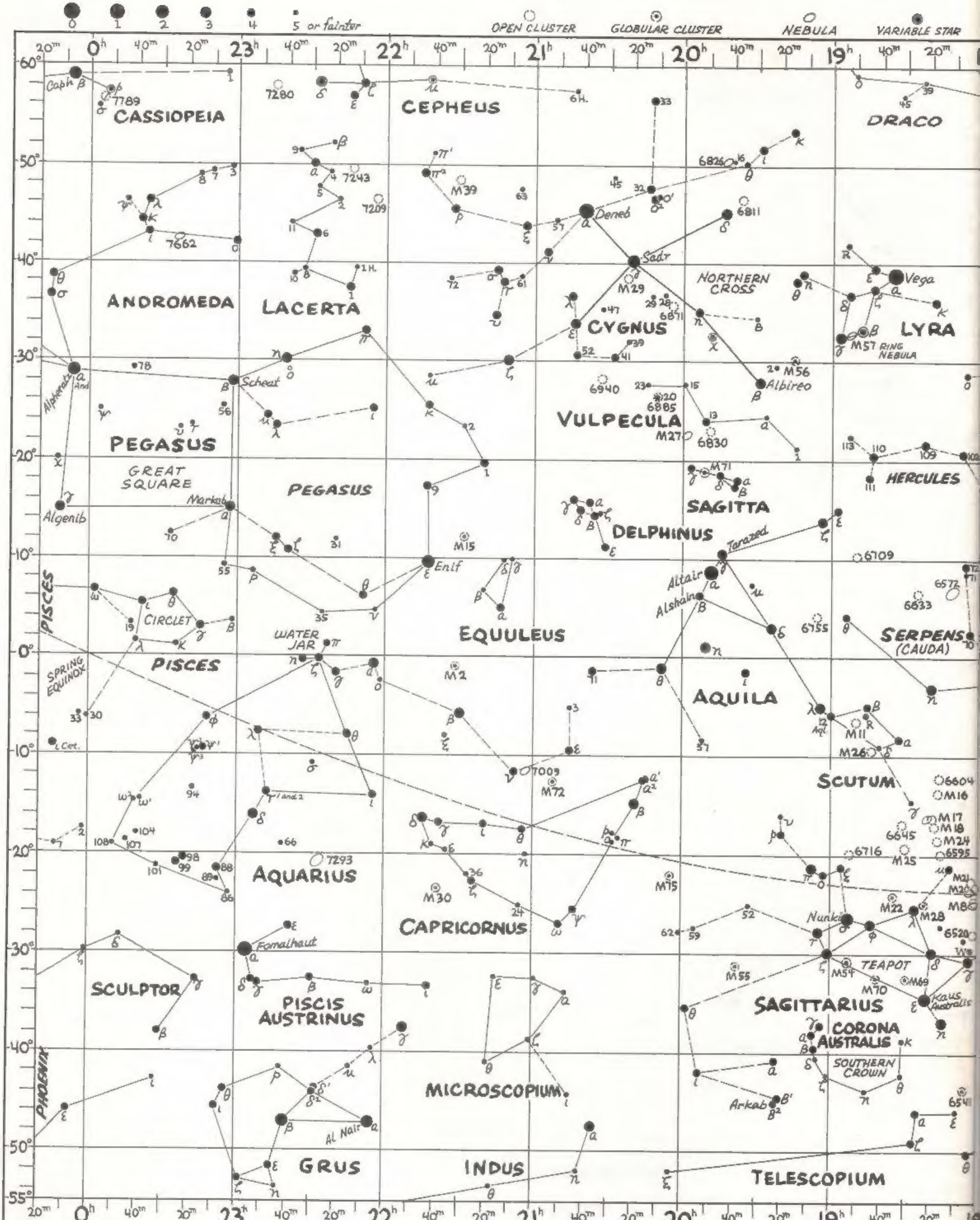
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OPEN CLUSTER
GLOBULAR CLUSTER
NEBULA
VARIABLE STAR
CASSIOPEIA
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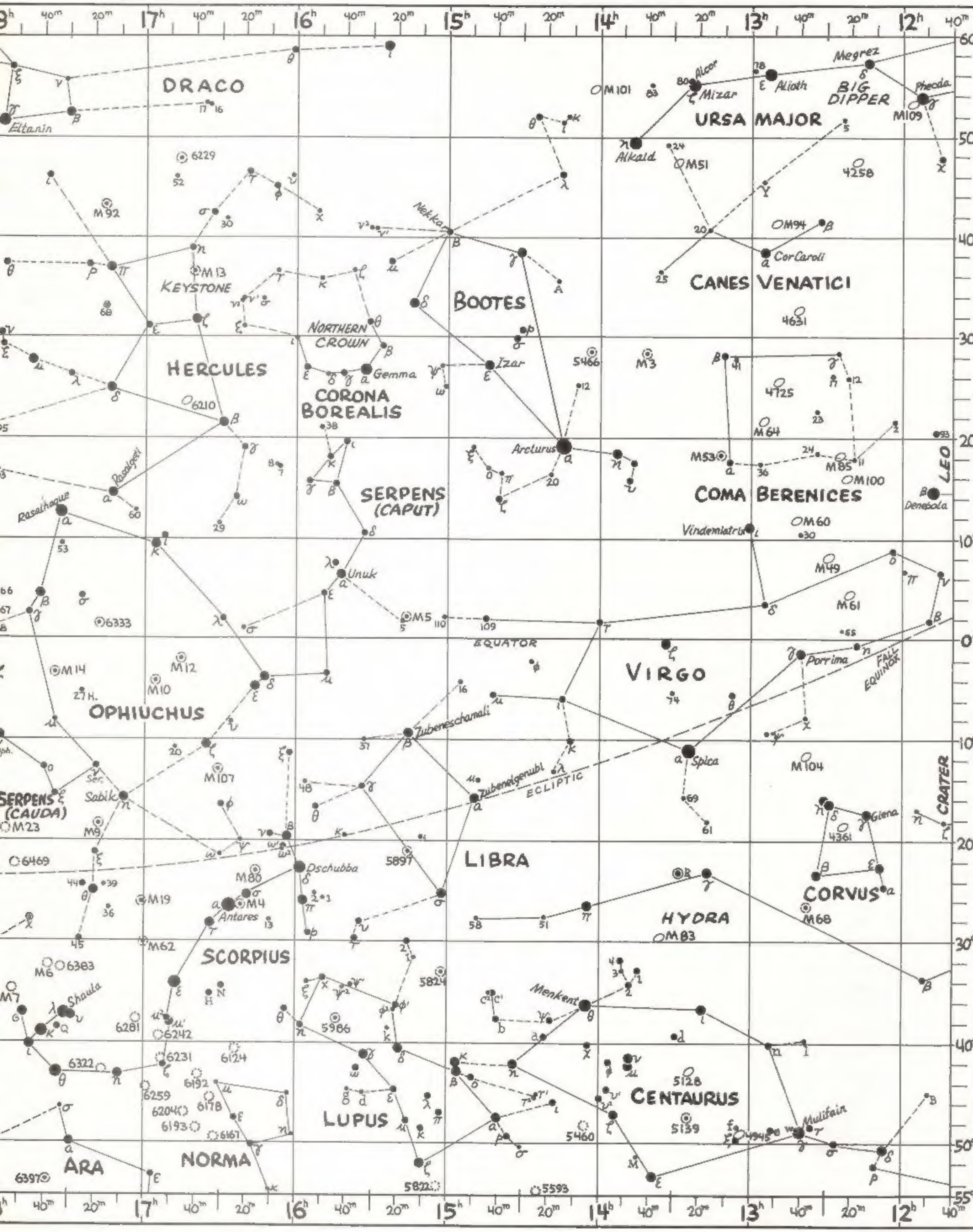
DRACO
ANDROMEDA
LACERTA
Deneb
Sadr
NORTHERN CROSS
Vega
LYRA
CYGNUS
M57 RING NEBULA
Alpheratz
Scheat
Albireo
VULPECULA
PEGASUS
GREAT SQUARE
Markab
Algenib
SAGITTA
HERCULES
DELPHINUS
Tarazed
Enif
Altair
Alshain
PISCES
CIRCLET
WATER JAR
EQUULEUS
SERPENS (CAUDA)
SPRING EQUINOX
AQUILA
SCUTUM
AQUARIUS
CAPRICORNUS
Nunki
Fomalhaut
SCULPTOR
PISCIS AUSTRINUS
TEAPOT
SAGITTARIUS
Kaus Australis
CORONA AUSTRALIS
SOUTHERN CROWN
PHOENIX
MICROSCOPIUM
Arkab
Al Nair
GRUS
INDUS
TELESCOPIUM


DRACO
Eltanin
URSA MAJOR
BIG DIPPER
Megrez
Alioth
Alcor
Mizar
Alkaid
Phecda
M101
M51
M109
4258
M94
Cor Caroli
CANES VENATICI
4631
Nekkar
BOOTES
Izar
Arcturus
5466
M3
HERCULES
KEYSTONE
M92
M13
6229
6210
NORTHERN CROWN
CORONA BOREALIS
Gemma
4725
M64
M53
M85
M100
COMA BERENICES
Denebola
LEO
M60
Vindemiatrix
M49
M61
Rasalgeti
Rasalhague
SERPENS (CAPUT)
Unuk
M5
6333
EQUATOR
VIRGO
Porrima
FALL EQUINOX
M14
M12
M10
OPHIUCHUS
Zubeneschamali
Zubenelgenubi
ECLIPTIC
Spica
M104
M107
Sabik
SERPENS (CAUDA)
M23
M9
CRATER
Giena
4361
CORVUS
6469
M80
M4
Dschubba
5897
LIBRA
Antares
M19
HYDRA
M68
M83
M62
SCORPIUS
M6
6383
M7
Shaula
5824
Menkent
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6242
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6192
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CENTAURUS
LUPUS
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ARA
NORMA
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12h
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30°
20°
10°
0°
-10°
-20°
-30°
-40°
-50°
-55°

STAR AND CONSTELLATION PRONOUNCING GUIDE

Acamar	AKE-uh-mar
Achemar	AKE-er-nar
Adhara	add-DARE-ah
Al Nair	al-NARR
Albireo	al-BURR-ee-oh
Alcor	AL-core
Aldebaran	al-DEBB-uh-ran
Alcyone	al-SIGH-oh-nee
Alderamin	al-DARE-uh-min
Algenib	al-JEE-nib
Algol	AL-gall
Alioth	ALLEY-oth
Alkaid	al-KADE
Almach	AL-mack
Alnilam	AL-nih-lam
Alnitak	AL-nih-tack
Alpha Centauri	AL-fah-sent-TOE-rye
Alphecca	al-FECK-ah
Alpheratz	al-FEE-rats
Altair	al-TAIR
Andromeda	an-DROM-eh-dah
Antares	an-TAIR-eez
Aquarius	ack-QUAIR-ee-us
Aquila	ACK-will-uh
Arcturus	ark-TOO-russ
Aries	A-rih-eez
Auriga	or-EYE-gah
Avior	ah-vee-OR
Bellatrix	bell-LAY-trix
Betelgeuse	BET-el-jews
Bootes	bow-OH-teez
Canes Venatici	KAY-neez ven-AT-iss-si
Canis Major	KAY-niss MAY-jer
Canis Minor	KAY-niss My-ner
Canopus	can-OH-puss
Capella	kah-PELL-ah
Caph	kaff
Carina	ka-RYE-nah (or, ka-REE-nah)
Castor	KASS-ter
Cassiopeia	kass-see-oh-PEE-ah
Centaurus	sen-TOR-us
Cepheus	SEE-fee-us (or, SEE-fus)
Cetus	SEE-tus
Coma Berenices	KOH-mah Bear-en EYE-sees
Cor Caroli	kor-CARE-oh-lie
Corona Borealis	kor-OH-nah bo-ree-ALICE
Corvus	CORE-vus
Cygnus	SIG-nus
Delphinus	dell-FINE-us
Delta Cephei	DELL-ta-SEE-(fee-eye
Deneb	DEN-ebb
Denebola	den-NEB-oh-lah
Diphda	DIFF-dah
Draco	DRAY-ko
Dschubba	JEW-bah
Dubhe	DO-be
Eltanin	el-TAY-nin
Elnath	el-NATH
Enif	ENN-if
Equuleus	ek-KWOO-lee-us
Eridanus	eh-RID-uh-nuss
Fomalhaut	FOAM-al-ought
Gemini	GEM-in-eye (or, GEM-in-knee)
Hadar	HAD-er
Hamal	HAM-el
Hyades	HI-ad-eez
Kaus Australis	KOSS-oss-TRAY-liss
Kochab	KOE-kab
Lacerta	la-SIR-tah
Lapus	LEE-puss
Libra	LYE-bra (or, LEE-bra)
Lupus	LEW-puss
Lyra	LYE-rah
Markab	MAR-keb
Megrez	ME-grez
Menkar	MEN-kar
Menkalinan	men-KAL-in-nan
Menkent	MEN-kent
Merak	ME-rack
Mintaka	min-TACK-uh
Mira	MY-rah
Mirfak	MURR-fak
Mirzan	MURR-zan
Mizar	MY-zar
Monocerous	mon-OSS-err-us
Nunki	NUN-key
Ophiuchus	off-ih-YOU-kuss
Orion	oh-RYE-un
Pegasus	PEG-uh-suss
Perseus	PURR-see-us (or, PURR-suss)
Phact	fact
Phecda	FECK-dah
Pisces	PIE-sees
Pisces Austrinus	PIE-sees oss-TRY-nus
Pleiades	PLEE-ah-deez
Polaris	pole-AIR-iss
Pollux	PAW-lux
Procyon	PRO-see-on
Rasalgethi	ras-el-GEE-thee
Rasalhague	ras-el-haig-we
Rigel	RYE-jell
Sabik	SAY-bik
Sadr	sadder
Sagitta	sah-JIT-tah
Sagittarius	saj-ih-TAIR-ee-us
Saiph	saw-eef (or, safe)
Scheadar	SHED-durr
Scheat	SHEE-at
Scorpius	SKOR-pih-us
Shaula	SHAW-lah
Scutum	SKEW-tum
Sirius	SEER-ee-us
Spica	SPY-ka
Tarazed	TAR-uh-zed
Taurus	TOR-russ
Thuban	THEW-ban
Vega	VEE-gah (or, VAY-gah)
Virgo	VURR-go
Vulpecula	vul-PECK-you-lah
Wezen	WEE-zen
Zubenelgenubi	zoo-ben-ell-jen-NEW-bee
Zubeneschemali	zoo-ben-ess-sha-MAY-lee

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